

THE PRINTING OF THE SECURITIES OF THE UNITED STATES.

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Q U E R I E S  
OF THE  
COMMITTEE ON EXPENDITURES IN THE TREASURY DEPARTMENT,

AND

*Answers thereto from the Treasury Department.*

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APRIL 3, 1876.—Ordered to be printed.

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*Communication from Hon. B. H. Bristow, Secretary of the Treasury, in response to interrogatories propounded by the Committee on Expenditures in the Treasury Department.*

The House of Representatives having directed the Committee on Expenditures in the Treasury Department to make certain investigations in regard to the printing of the securities of the United States, submit the following questions to the Hon. Secretary of the Treasury, with the request that the proper parties may answer the same in writing, and at as early a day as is practicable.

1. State the total cost of the work executed in the Bureau of Engraving and Printing, during the fiscal year ended July 1, 1875; the cost of the work on same done outside of the Bureau, and the cost of the paper and materials, tools, and machinery used in said Bureau, and state what amounts have been paid by or have been charged to appropriations other than for the national loan, and what amount has been charged to the national-loan accounts.

2. Does the report of the Chief of the Bureau of Engraving and Printing for the fiscal year ended June 30, 1875, give a full and complete statement of work done in the Bureau during that year? If not, state what other work was done.

3. Give a tabular statement of the work done in the Bureau since July 1, 1875; the number of impressions and denominations of United States notes, fractional currency, bonds, stamps, and miscellaneous work; state the number of plate-printings, surface-printings, numbering, trimming, separating, &c.; give the amount of work on above done outside of the Bureau, and the cost of the same.

4. Give the cost of any miscellaneous work done in the Bureau since July 1, 1875, not chargeable to the national loan.



5. State the amount of all warrants since July 1, 1875, issued or to be issued for work done since 1st July, 1875, or carried to the credit of the national loan since said date.

6. Give the actual number of employés in the Bureau each month since 1st July, 1875; their general duties, and the actual monthly pay-roll for each division.

7. State if the pay-rolls furnished include the salaries of all the officers and clerks of the Bureau.

8. Are the amounts paid to the employés affixed to their names when they sign the pay-roll?

9. Give the receipts, deliveries, and balances of paper for the United States notes and fractional currency by the Bureau of Engraving and Printing during each of the fiscal years of 1874, 1875, and 1876.

10. Give the number of impressions, complete and incomplete, of United States notes, fractional currency, bonds, and stamps on hand at the close of the fiscal years of 1874, 1875, and at the present time.

11. Has the appropriation made at the second session of the Forty-third Congress, for the expenses of the national loan for the fiscal year ending June 30, 1876, been used exclusively for paper, labor, materials, and tools necessary in executing the notes, bonds, and other securities of the United States?

12. Has any portion of the amount appropriated for the expenses of the national loan for the fiscal year commencing July 1, 1875, been paid for work executed either in or outside of the Bureau, previous to that date?

13. State the relative detailed cost per 1,000 impressions for printing the seals on United States notes and fractional currency, by plate-printing and by surface-printing.

14. Does the price or cost of surface-printing include the expense of the process known as water-proofing? If not, what amount per 1,000 impressions should be added for such process?

15. State the amount expended on account of the water-proofing process during the fiscal year ended June 30, 1875, and also the amount expended for same since July 1, 1875.

16. Has the work done in the Bureau, on national-bank currency since July 1, 1875, been paid for exclusively out of the special appropriation for national currency? If not, from what source has it been paid?

17. State what amount has been expended for engraving, printing, paper, and materials for United States notes and fractional currency, from July 1, 1869, to June 30, 1875.

18. State what amount has been expended for engraving, printing, paper, and materials for national-bank notes, from the adoption of the national-bank act in 1864, to July 1, 1875.

19. State the amount expended by the Commissioner of Internal Revenue for revenue-stamps, during the fiscal years ended June 30, 1874, and June 30, 1875, and the amount expended or contracted for since July 1, 1875, and where and by whom the same were executed.

20. State the receipts, deliveries, and balance on hand of United States stamps, by the Bureau of Internal Revenue, during each of the fiscal years of 1873, 1874, and 1875, and in 1876 up to the present time.

21. Does the amount given in answer to the fifteenth question, include the expense of labor in the use of the water-proofing process, and also the amount of royalty paid for its use?

22. State if any commission, and composed of what persons, by name, has examined the value of the water-proofing process, as recommended



in the report of the Committee on Banking and Currency, made February 16, 1875; and, if so, please annex a copy of their report, if any has been made. If no report has been made to you in writing, has any and what oral report been made to you? And have you urged the parties having the matter in charge to make report to you?

SMITH ELY, JR.,  
Chairman.

TREASURY DEPARTMENT, March 31, 1876.

SIR: I transmit herewith the answers of this Department to the questions submitted by you on the 18th instant.

I have the honor to be, very respectfully, &c.,

B. H. BRISTOW,  
Secretary.

Hon. SMITH ELY, Jr.,  
Chairman Committee on Expenditures of the Treasury Department,  
House of Representatives.

*Answers to queries submitted by the Committee on Expenditures in the Treasury Department of the House of Representatives.*

#### ANSWER TO QUERY No. 1.

Aggregate cost of all kinds of work for the fiscal year ended June 30, 1875 .....	\$2,080,278 37
Amount charged to and repaid from other appropriations, &c. ....	568,409 74
Balance .....	<u>1,511,868 63</u>

Chargeable to the appropriation for the national loan, as follows:

Salaries Bureau of Engraving and Printing.....	\$25,977 40	
Labor and expenses of engraving and printing.....	1,122,587 52	
Material required in the work of engraving and printing.....	139,780 17	
Engravers' tools, &c., machinery and repairs.....	49,426 53	
Paper for notes, bonds, and other securities.....	174,097 01	
		<u>1,511,868 63</u>
From this should be deducted, being the amount chargeable against other appropriations, but not yet repaid from them.....		11,566 03

Leaving a net balance chargeable to above appropriation of..... 1,500,302 60

Out of the appropriation for labor and expenses of engraving and printing there was paid for engraving and printing backs of United States notes and fractional currency outside the Bureau, \$404,162.16.

#### ANSWER TO QUERY No. 2.

The report of the Chief of the Bureau of Engraving and Printing for the fiscal year ended June 30, 1875, gives a full and complete statement of the work finished and delivered by the Bureau during that year. The amount of work on hand unfinished at the commencement and end of the fiscal year is not set forth in the report.



ANSWER TO QUERY No. 3.

Work done in the Bureau since July 1, 1875.

FRACTIONAL CURRENCY.

	50-cents sheets.	25-cents sheets.	10-cents sheets.
Backs counted and examined, faces and seals, (all plate-printings,) with counts and examinations, water-proofed, pressed, needled, trimmed, separated, packed, and boxed.	822, 500	5, 222, 000	4, 538, 500
Backs counted and examined, partly faced, sealed, counts, and examinations.	681, 646	1, 272, 814	942, 570
Backs counted and examined, partly faced, counts, and examinations	131, 800	303, 700	214, 800
Backs counted and examined, faces and seals, counts, examinations, water-proofed, partly needled and trimmed	47, 750	179, 650	161, 280
Total.....	1, 733, 696	6, 978, 164	5, 857, 150

UNITED STATES NOTES.

	1-dollar sheets.	2-dollar sheets.	5-dollar sheets.	10-dollar sheets.	20-dollar sheets.	100-dollar sheets.	500-dollar sheets.
Backs counted and examined, faces and seals, (all plate-printings,) with counts and examinations, pressing, numbering, trimming, separating, and packing.	2, 438, 000	699, 000	592, 000	131, 000	55, 000	30, 500	8, 000
Backs counted and examined, partly faced, seals, counts, examinations, &c.....	994, 497	515, 150	35, 862	86, 091	10, 700	.....	.....
Backs counted and examined, partly faced, counts, and examinations	278, 675	54, 682	39, 894	42, 400	36, 200	.....	.....
Backs counted and examined, faces, seals, and partly numbered, counts, and examinations.	120, 853	53, 500	18, 560	14, 700	19, 200	.....	.....
Total.....	3, 832, 025	1, 322, 332	686, 316	274, 191	121, 100	30, 500	8, 000



*National-bank currency, series 1875.*

Sheets.

Black and green-tint backs, counts and examinations, faces plate-printed and examined, seals surface-printed and examined, charter numbered, bank and Treasury numbers, pressing and trimming .....	1, 803, 941
Black and green-tint backs, counts and examinations .....	516, 827
Black and green-tint backs, counts and examinations, and partly faced and examined .....	18, 250
Black and green-tint backs, counts and examinations, faces plate-printed and examined, seals surface-printed and examined, charter numbered, bank and Treasury numbers, counts, pressing, and trimming .....	38, 439
	<hr/> 573, 516
Total .....	2, 377, 457

*National-bank currency, old series.*

Received, counted and examined, scaled, numbered, charter numbered, surface-pressing, counts and examinations, trimming, &c .....	106, 280
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*Registered consol. bonds, act March 3, 1865, dated 1868.*

Plate backs, faces, seals, numbering, counts, &c .....	1, 058
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*Gold certificates, (three plate-printings.)*

Plate-printed, plate-faced, plate-sealed, counts and examinations, numbering, trimming, pressing, separating, packing .....	13, 250
Plate-printed, plate-faced, plate-sealed, counted and examined .....	2, 121
Plate-tinted, plate-faced, counted and examined, and partly plate-sealed .....	3, 547
Plate-tinted, plate-faced, plate-sealed, counted and examined, pressing, &c .....	1, 057
	<hr/> 6, 725
Total .....	19, 975

*Registered consols of 1865.*

Plate-tint and seal, plate-back, plate-face, numbered and examinations, &c..	19, 507
Plate-backs .....	2, 200
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Total .....	21, 707

*5-20 registered-bonds, act 30th June, 1864.*

Plate-backs, tints, seals, faces, numbering, examining, pressing, &c....	1, 615
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*Registered funded-loan bonds.*

Plate-backs, faces, seals, numbering, &c .....	2, 749
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*Coupon funded loan-bonds.*

Plate-backs, faces, seals, numbering, counts and examinations, pressing, &c.	55, 600
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*10-40 registered bonds, act of March 3, 1864.*

Plate-backs, faces, seals, numbering, counts, &c .....	8, 588
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*6 per cent. registered bonds, act of July 17 and August 5, 1861.*

Plate-backs, faces, seals, numbering, counts, &c .....	6, 854
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*Coin certificates of deposit.*

Received, counted and examined, signatures surface-printed, counted and examined .....	10, 000
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*Currency certificates of deposit.*

Received, counted and examined, signatures surface-printed, counted and examined .....	3, 000
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<i>Coin certificates of deposit.</i>	
Series 1875, surface-printed and numbers marked out, numbered, counted and examined .....	Sheets. 3, 000
<i>Coin certificates of deposit.</i>	
Series 1875 and signatures surface-printed, numbers marked out, numbered, counted and examined .....	22, 500
<i>Registered consols, dated 1867.</i>	
Backed, faced, sealed, &c .....	2, 010
Partly backed, faced, sealed .....	4, 400
Partly backed, faced, sealed, and partly numbered .....	5, 150
Total .....	11, 569
<i>Registered bonds, act of March 3, 1863, loan of 1881.</i>	
Plate-backs, faces, seals, numbering, counts, &c .....	1, 895
<i>Custom cigar-stamps.</i>	
Two plate-printings, counts and examinations, pressing, and perforating ...	143, 472
<i>Special-tax stamps for liquors and for tobacco, 1876.</i>	
Faced, surface-sealed, numbered, pressed, counts and examinations .....	585, 300
<i>Custom lock-seal stamps.</i>	
Two printings, numbering, &c .....	1, 290
<i>Internal-revenue lock-seal stamps.</i>	
Printed, numbered, perforated, &c .....	1, 400
<i>Pension-checks, five subjects.</i>	
One plate-printing, two surface-printings, numbered, pressed, trimmed, perforated, counts and examinations, bound in 695 volumes .....	149, 784
<i>Disbursing-officers' checks, four subjects.</i>	
One plate-printing, one surface-printing, numbered, pressed, trimmed, counts and examinations, bound in 42 volumes .....	17, 550
One plate-printing, one surface-printing, numbered, pressed, trimmed, counts and examinations, two subjects, bound in 975 volumes .....	65, 125
<i>Commissioners Freedman's Savings and Trust Company, four subjects.</i>	
One plate-printing, one surface-printing, numbered, pressed, trimmed, counts and examinations, bound in 60 volumes .....	15, 000
<i>Drawback certificates, one subject.</i>	
One plate-printing, pressed, trimmed, counts and examinations, bound in 10 volumes .....	2, 000
<i>Coupon interest-checks, eight subjects.</i>	
One plate-printing, one surface-printing, numbered, pressed, trimmed, perforated, counts and examinations, bound in 57 volumes .....	5, 700
<i>Registered interest-checks, eight subjects.</i>	
One plate-printing, one surface-printing, numbered, pressed, trimmed, perforated, counts and examinations, bound in 15 volumes .....	1, 500



# PRINTING OF UNITED STATES SECURITIES.

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## *Post-Office Department drafts, two subjects.*

	Sheets.
One plate-printing, one surface-printing, numbered, pressed, trimmed, counts and examinations, bound in 60 volumes .....	15, 050

## *Post-Office Department warrants, two subjects.*

One plate-printing, one surface-printing, numbered, pressed, trimmed, counts and examinations, bound in 35 volumes .....	8, 800
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## *State Department checks, four subjects.*

One plate-printing, numbered, pressed, trimmed, counts and examinations, bound in 3 volumes .....	750
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## *Drafts on warrants, four subjects.*

One plate-printing, one surface-printing, numbered, pressed, trimmed, counts and examinations, bound in 40 volumes .....	10, 000
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## *Coin-drafts, United States Treasury, four subjects.*

One plate-printing, one surface-printing, numbered, pressed, trimmed, counts and examinations, bound in 2 volumes .....	500
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## *Transfer redemption-checks, five subjects.*

One plate-printing, numbered, pressed, trimmed, counts and examinations, bound in one volume .....	200
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## *Certificates of license, one subject.*

One plate-printing, numbered, pressed, trimmed, counts and examinations, bound in 27 volumes .....	8, 100
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## *Collection-checks, four subjects.*

One plate-printing, two surface-printings, pressed, trimmed, perforated, separated, counts and examinations .....	9, 000
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## *Pension-certificates, one subject.*

Two plate-printings, pressed, trimmed, counts and examinations .....	16, 903
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## *Hydrometer-labels, twenty subjects.*

One plate-printing, pressed, trimmed, counts and examinations .....	318
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## *United States passports, one subject.*

One plate-printing, pressed, trimmed, counts and examinations .....	5, 500
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## *Centennial certificates, one subject.*

One plate-printing, one surface-printing, numbered, pressed, trimmed, and examinations .....	6, 000
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## *Certificates of non-indebtedness, two subjects.*

One plate-printing, numbered, pressed, trimmed, counts and examinations, bound, &c .....	500
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## *District collection-checks, four subjects.*

One plate-printing, one surface-printing, numbered, pressed, trimmed, counts, and examinations, bound in 43 volumes .....	4, 800
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## *Certificates of organization, one subject.*

One plate-printing, pressed, trimmed, counts, and examinations .....	203
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*Coin-checks, two subjects.*

	Sheets.
One plate-printing, two surface-printings, bronzing, numbered, pressed, trimmed, counts, and examinations, bound in 20 volumes.....	500

*Coin-checks, four subjects.*

One plate-printing, two surface-printings, bronzing, numbered, pressed, trimmed, counts, and examinations, bound in 12 volumes.....	2,200
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In addition to the above, the Bureau has charge of and repairs all the machinery in connection with the Treasury Department, and also for the destruction of redeemed United States notes, fractional currency, bonds, &c., by maceration.

Of the above work the following is executed outside of the Bureau of Engraving and Printing:

The backs of the ten-cent notes, at \$19 per 1,000 impressions or sheets.

The backs of the twenty-five-cent notes, at \$20 per 1,000 impressions or sheets.

The backs of the fifty-cent notes, at \$19.50 per 1,000 impressions or sheets.

The backs of the one-dollar notes, at \$19 per 1,000 impressions or sheets.

The backs of the two-dollar notes, at \$19 per 1,000 impressions or sheets.

The backs of the five-dollar notes, at \$20 per 1,000 impressions or sheets.

The backs of the ten-dollar notes, at \$20 per 1,000 impressions or sheets.

The backs of the twenty-dollar notes, at \$20 per 1,000 impressions or sheets.

The backs of the one hundred-dollar notes, at \$20 per 1,000 impressions or sheets.

The backs of the five hundred-dollar notes, at \$19 per 1,000 impressions or sheets.

The backs of the national-bank currency, at \$37.50 per 1,000 impressions or sheets.

The backs of the coupon-bonds of the funded loan, at \$30 per 1,000 impressions or sheets.

The backs of the registered bonds of the funded loan, at \$17 per 1,000 impressions or sheets.

## ANSWER TO QUERY No. 4.

The cost of miscellaneous work done in the Bureau since 1st July, 1875, not chargeable to the national loan, is \$154,510.

## ANSWER TO QUERY No. 5.

*Amount of warrants issued for work done since 1st July, 1875, or carried to the credit of the national loan since said date.*

	Debtor.	Creditor, repay and transfers.
Salaries.....	\$20,000 00	
Labor and expenses.....	1,204,951 55	\$89,556 31
Materials.....	200,255 25	255 25
Engravers' tools.....	50,000 00	
Paper, &c.....	230,000 00	4,895 27



## ANSWER TO QUERY No. 6.

There have been employed from July 1, 1875, to February 12, 1876, the number of employés indicated below, consisting of engravers, transferrers, plate-cleaners, provers, plate-hardeners, custodians, vault-keepers, plate-printers and apprentices, surface-printers, register-clerks, binders, paper-cutters, box-makers, pressmen, machinists, carpenters, ink-mixers, engineers, firemen, gas and steam fitters, examiners, counters, wetters, numberers, trimmers, separators and perforators, needlers, trimmers, packers, box-carriers, laborers, cleaners, watchmen, superintendents, clerks of divisions, miscellaneous clerks, and messengers.

1875—July .....	1,350
August .....	1,375
September .....	1,413
October .....	1,452
November .....	1,502
December .....	1,531
1876—January .....	1,669
February 1 to 12 .....	1,699



## Recapitulation of the monthly pay-rolls from July, 1875, to February, 1876, inclusive.

Division.	July, 1875.	August.	September.	October.	November.	December.	January, 1876.	February.
Office .....	\$2, 457 45	\$1, 958 95	\$2, 245 15	\$2, 337 50	\$2, 234 40	\$2, 355 30	\$2, 391 45	\$2, 029 55
Watchmen .....	4, 670 75	4, 636 25	4, 102 50	4, 475 00	4, 620 50	4, 551 25	4, 905 25	3, 019 25
Dressing-room attendants, (males and females) .....	699 00	715 00	760 00	790 35	792 00	865 50	1, 050 30	391 45
Cleaners .....	711 75	785 75	811 50	803 25	862 00	881 25	1, 892 00	386 35
Miscellaneous .....	7, 728 50	8, 202 35	9, 380 85	11, 283 70	9, 998 80	11, 355 25	11, 723 20	7, 754 50
Engraving division .....	6, 145 50	5, 545 45	6, 076 15	6, 374 75	6, 334 59	7, 414 50	8, 095 65	4, 267 55
Machine division .....	4, 723 85	4, 956 65	4, 370 20	4, 871 65	5, 867 20	5, 621 32	6, 235 10	3, 200 75
Counting division .....	2, 330 25	2, 404 40	2, 947 00	3, 139 90	3, 653 32	3, 955 95	4, 002 70	2, 191 25
Wetting division .....	2, 835 55	3, 084 80	3, 193 25	3, 421 00	3, 385 10	3, 774 95	4, 292 50	1, 814 95
Face-printing division .....	21, 147 40	22, 246 00	26, 457 50	28, 114 25	26, 398 90	32, 040 60	41, 214 45	17, 360 55
Sealing division .....	11, 060 30	13, 259 25	15, 488 40	16, 061 00	16, 349 10	19, 078 45	19, 452 95	8, 572 70
Surface-printing division .....	2, 272 05	2, 269 85	2, 354 50	2, 511 65	2, 524 50	2, 575 81	2, 839 32	1, 446 98
Examining division .....	7, 378 55	7, 070 95	8, 105 40	8, 815 75	8, 846 45	9, 674 55	10, 735 90	4, 311 05
Drying division, day and night, (2 sets of hands) .....	2, 747 65	4, 405 20	4, 348 00	4, 362 30	4, 981 45	5, 773 26	5, 174 67	1, 613 01
Pressing division .....	2, 188 70	2, 598 30	2, 560 60	2, 593 95	2, 656 25	2, 729 55	2, 656 40	1, 159 95
Numbering division .....	4, 094 20	4, 109 80	3, 555 40	3, 849 90	4, 073 70	4, 448 11	6, 639 67	2, 676 56
Separating division .....	5, 656 30	6, 453 35	6, 697 30	7, 037 30	7, 593 50	8, 443 06	9, 201 07	3, 734 36
Binding division .....	1, 602 50	1, 884 10	1, 773 00	1, 902 35	1, 897 05	2, 030 56	2, 192 62	2, 198 26
Store division .....	1, 223 75	1, 282 35	1, 434 50	1, 498 10	446 10	449 75	441 10	325 75
Ink-mill .....	1, 166 70	1, 920 50	288 75	252 25	312 25	337 50	371 00	123 50
Custodians and United States sealer employes .....	328 60	750 70	1, 124 55	1, 110 10	1, 111 00	1, 168 00	1, 793 05	908 80
Check division .....	743 35	715 80	715 80	746 70	715 25	856 75	837 40	800 90
Engineers, firemen, laborers, &c., employed in destruction of redeemed United States notes and fractional currency.								
Total .....	93, 912 65	99, 839 95	108, 150 30	115, 272 70	115, 653 41	*130, 431 22	†147, 137 75	70, 287 97

\* During the month of December the employes were required, by the exigencies of the service, to work over-hours.

† During the month of January a large portion of the force worked until 6 o'clock each day.



ANSWER TO QUERY No. 7.

Yes.

ANSWER TO QUERY No. 8.

The amounts paid to employes are not placed opposite their names when they sign the roll. The time made by employes cannot be ascertained, nor the amounts due computed, until a day or two before the close of the month; and in order to facilitate the payments to so large a number of persons, the names are entered on the rolls and the rolls are signed in advance. The rolls after being certified, are given to the disbursing-clerk of the Department, who makes the payments, and the same time checks on the roll the amount entered opposite the name of each person paid, and in their presence.

ANSWER TO QUERY No. 9.

The Bureau of Engraving and Printing receives no blank paper for fractional currency or United States notes. These securities are received partly printed, that is to say, the blank paper is delivered to the bank-note companies by the Department and then delivered to the Bureau partly printed.

ANSWER TO QUERY No. 10.

*Number of impressions of United States notes, bonds, fractional currency, &c., complete and incomplete, on hand at the close of the fiscal years 1874 and 1875, and on March 20, 1876.*

	June 30, 1874.	June 30, 1875.	March 20, 1876.
United States notes .....	128, 734	2, 689, 030	2, 320, 964
Fractional currency .....	2, 780, 861	1, 207, 400	3, 986, 000
National-bank currency .....	44, 668	121, 794	569, 766
National currency, gold notes, series 1875 .....			1, 791
Circulating notes for national-banking associations .....	9, 682	9, 878	9, 878
Registered bonds, funded loan .....			2, 749
Coupon bonds, funded loan, July 14, 1870 .....	19, 403	30, 150	
Registered consols, 1865 .....			2, 200
Registered consols, 1867 .....			8, 800
Registered consols, 1867, returned from Register's Office for additional work .....			16, 000
Gold-certificates .....			6, 750
Certificates of deposit for United States notes, June 8, 1872-1875 .....			1, 750
Customs cigar and cigarette stamps, series 1873 .....	*57, 446	*2, 200	1, 800
Customs cigar and cigarette stamps, series 1875 .....		*26, 118	48, 872
Lock-seal stamps .....	1, 641	1, 641	4, 738
Custom lock-seal stamps .....		5, 870	
Tax-paid stamps .....	97, 520		
Tax-paid stamps, in bonds .....	248		
Distilled-spirits stamps .....	333, 875		
Beer-stamps .....	130, 670		
Special-tax stamps for liquors, 1873 .....	†26, 790		
Special-tax stamps for liquors, 1874 .....	†30, 620		
Special-tax stamps for liquors, 1875 .....		328½	
Special-tax stamps for liquors, 1876 .....			5, 089
Special-tax stamps for tobacco, 1873 .....	†22, 450		
Special-tax stamps for tobacco, 1874 .....	†45, 755		
Special-tax stamps for tobacco, 1875 .....		200	
Special-tax stamps for tobacco, 1876 .....			39, 880
Tobacco-stamps, large denominations .....	202, 309		
Tobacco-stamps, small denominations .....	6, 613		
Cigarette and cigar stamps .....	†1, 429, 445		
Strip tobacco-stamps .....	†1, 779, 771		
Strip snuff-stamps .....	†110, 759		
Stub snuff-stamps .....	†39, 400		
Sheet snuff-stamps, ounces .....	†2, 039		
Sheet snuff-stamps, pounds .....	†2, 103		
Brewers' permits .....	†47, 197		
Total .....	7, 340, 999	4, 094, 609½	7, 027, 037

\* Inc'uding blank paper.

† Including plain paper furnished by Bureau of Internal Revenue.



## ANSWER TO QUERY No. 11.

Except as stated in answer to query No. 4, the appropriation made at the second session of the Forty-third Congress for paper, labor, and expenses, materials, engravers' stock and tools, for printing the securities of the Government, as far as it has been expended, has been used exclusively for the purposes indicated in the act.

For the cost of the miscellaneous work the national-loan appropriation has been or will be re-imbursed.

## ANSWER TO QUERY No. 12.

No portion of the amount appropriated for paper, labor, and expenses, materials, engravers' stock, and machinery, for the present fiscal year, has been expended for work done previous to the commencement of the fiscal year.

## ANSWER TO QUERY No. 13.

The cost of plate-seals on fractional currency per 1,000 impressions is \$16.75.

The cost of surface-seals on the same, per 1,000 impressions, is \$4.31.

## ANSWER TO QUERY No. 14.

The cost of surface-printing does not include that of water-proofing. The cost of the latter is \$7.82 per 1,000 sheets.

## ANSWER TO QUERY No. 15.

Amount expended on water-proofing for year ended June 30, 1875:

Water-proofing material.....	\$66,336 90
Labor, &c.....	44,403 86
Total .....	110,740 76

Amount expended on water-proofing from July 1, 1875, to February 12, 1876:

Water-proofing material.....	\$44,291 40
Labor, &c.....	34,458 33
Total .....	78,749 73

## ANSWER TO QUERY No. 16.

All the work done in the Bureau on national-bank currency since July 1, 1875, has been paid for exclusively out of the special appropriation therefor.

## ANSWER TO QUERY No. 17.

From July 1, 1869, to June 30, 1875, there has been expended for engraving, printing, paper, and material for United States notes.....

From July 1, 1869, to June 30, 1875, there has been expended for engraving, printing, paper, and material for United States notes.....	\$3,194,751 93
In the same time there has been expended for the same for fractional currency.....	5,730,149 31
Total .....	8,924,901 24

## ANSWER TO QUERY No. 18.

The amount expended for engraving, printing, paper, and materials for national-bank notes, from July 2, 1864, to July 1, 1875, from appropriation for printing, is.....

The amount expended for engraving, printing, paper, and materials for national-bank notes, from July 2, 1864, to July 1, 1875, from appropriation for printing, is.....	\$2,599,550 56
To this should be added the cost of printing the seals, numbering and trimming, from July 1, 1869, to June 30, 1874, in the Bureau of Engraving and Printing, which has never been repaid to the appropriation for the national loan.....	84,701 05
Total .....	2,684,251 61

NOTE.—Prior to June 30, 1869, no account was kept of the cost of this work in the First Division National Currency Bureau, as the Bureau of Engraving and Printing was then called.



ANSWER TO QUERY No. 19.

Amount expended on account of internal-revenue stamps during fiscal year ended June 30, 1874 .....	\$564, 159 59
Amount expended for same during fiscal year ended June 30, 1875 .....	461, 856 86
Estimated expenditures for fiscal year ended June 30, 1876 .....	528, 000 00

Where and by whom the work has been done: Bureau of Engraving and Printing, Washington; J. R. Carpenter, Philadelphia; American Bank Note Company, New York; Continental Bank Note Company, New York; National Bank Note Company, New York; American Phototype Company, New York; Graphic Company, New York; Henry Skidmore, New York; John J. Crooke, New York; A. Trochsler, Boston; Morey & Sherwood, Chicago.

ANSWER TO QUERY No. 20.

*Internal-revenue stamps.*

Fiscal year ended June 30, 1873:

Balance on hand June 1, 1872 .....	\$19, 272, 040 22
Received from July 1, 1872, to June 30, 1873, inclusive .....	148, 747, 581 28½
Total .....	168, 019, 621, 50½
Amount delivered from July 1, 1872, to June 30, 1873, inclusive .....	119, 676, 852 21
Balance on hand at close of business June 30, 1873 .....	48, 342, 769 29½

Fiscal year ended June 30, 1874:

Balance on hand July 1, 1873 .....	\$48, 342, 769 29½
Received from July 1, 1873, to June 30, 1874 .....	107, 778, 154 24½
Total .....	156, 120, 923 54½
Amount delivered from July 1, 1873, to June 30, 1874 .....	106, 524, 673 42
Balance on hand at close of business June 30, 1874 .....	49, 596, 250 12½

Fiscal year ended June 30, 1875:

Balance on hand July 1, 1874 .....	\$49, 596, 250 12½
Received from July 1, 1874, to June 30, 1875 .....	81, 525, 985 90½
Total .....	131, 122, 236 02½
Amount delivered from July 1, 1874, to June 30, 1875 .....	106, 677, 719 54
Balance on hand at close of business June 30, 1875 .....	24, 444, 516 48½

Period from July 1, 1875, to February 29, 1876:

Balance on hand July 1, 1875 .....	\$24, 444, 516 48½
Received from July 1, 1875, to February 29, 1876, inclusive .....	86, 925, 823 93
Total .....	111, 370, 340 41½
Amount delivered from July 1, 1875, to February 29, 1876, inclusive ..	84, 680, 432 75
Balance on hand at close of business February 29, 1876 .....	26, 689, 907 66½

ANSWER TO QUERY No. 21.

The amount given in answer to the fifteenth query includes the cost of labor, steam for drying, and all material used in the water-proofing room, including the cost per gallon of the water-proofing material. No royalty is paid therefor, the material being purchased by the gallon.

ANSWER TO QUERY No. 22.

On the 30th of July last I addressed a letter to Prof. Joseph Henry, president of the National Academy of Sciences, asking that body to ex-



amine into the merits of the water-proofing process in use in the Bureau of Engraving and Printing, the matter being of a scientific nature, such as the academy is required to investigate and report upon by the act of March 3, 1863.

The president of the academy designated the following gentlemen, members thereof, to act as a commission for that purpose: Profs. J. E. Hilgard, C. F. Chandler, Henry Morton, and William Sellers.

On the 30th of August last I requested those gentlemen to commence their investigations, and at the same time I instructed the Chief of the Bureau of Engraving and Printing to afford them every facility therefor in his power.

I am advised that they called and examined the machinery for applying the "water-proofing" to the paper, and the manner in which it was done, and that they were furnished with a sample of the material and with specimens of blank and printed paper, water-proofed and not water-proofed. Every facility to conduct their investigation was afforded them, and they were furnished with all the information possible upon the subject.

During the autumn Professor Hilgard, chairman of the commission, called on me and submitted for my inspection a memorandum in writing of the principal points of his proposed report, which were deduced from his examination. He stated, as the result of his examination and tests, that he was convinced that the process in question was of great advantage and of great utility both as to durability and security, and that he would recommend that the Government should purchase the invention from the proprietor, with a view to a more economical application of the process.

The general tenor of the report having been thus foreshadowed by the chairman of the commission, I saw no reason, at that time, and have had no cause since, to question the usefulness of the process, and I therefore continued its use until the Bureau was closed and work on the fractional currency stopped.

As yet, no formal or further report from the commission to whom this matter was referred has been received.

Some time since, I requested Prof. John M. Ordway, of the Massachusetts Institute of Technology, of Boston, and Prof. H. B. Nason, of the Polytechnic Institute of Troy, N. Y., who had several years ago examined into the merits of this process, to make further investigations, and they were furnished with facilities for doing so.

I inclose a copy of Professor Ordway's report; that of Professor Nason has not yet been received.

Professor Henry has recently procured additional sheets of water-proofed and not water-proofed paper for the purpose of further testing the matter.

On the first instant I requested him, by letter, to have the report of the commission made as soon as practicable, it having already been delayed a considerable time.

Professor Ordway's report herewith.

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MASSACHUSETTS INSTITUTE OF TECHNOLOGY,  
*Boston, February 24, 1876.*

DEAR SIR: Having been requested, through you, by the honorable the Secretary of the Treasury, to examine into the water-proofing process,



during a recent visit to Washington, "to ascertain whether there has been any change in the material," I beg leave to report as follows:

A good part of two days was devoted to examining the operations conducted by the Bureau of Engraving and Printing. Viewing the whole from a practical manufacturer's stand-point, I must say that, though the work of the Bureau is done under some disadvantages on account of limited space, it is done with admirable care, skill, and economy.

For experiments on the effects of water-proofing, as at present carried on, I selected from a lot of printed and stamped 25-cent currency, two sheets apparently alike in colors, thickness, and weight. One being reserved as it was, the other was passed, in my presence, through the water-proofing operations, along with the regular work. Both were pressed as usual. There being neither time nor facilities for making tests on the spot, the two sheets were duly receipted for, with the understanding that they should be destroyed or returned, and they were brought home for comparative trials.

1. The unprepared sheet weighed 7.3538 grams; the water-proofed sheet weighed 7.5488 grams; showing a gain of 0.1950 gram, or 2.65 per cent. in water-proofing.

2. Six pieces of exactly the same size, 50 by 63 millimeters, were cut out of each sheet and weighed to ascertain how much the thickness may vary in different parts of the same sheet of paper.

A a weighed 0.2870 gram.	B 1 weighed 0.2973 gram.
A b weighed 0.2943 gram.	B 2 weighed 0.2987 gram.
A c weighed 0.2845 gram.	B 3 weighed 0.2947 gram.
A d weighed 0.2845 gram.	B 4 weighed 0.2995 gram.
A f weighed 0.2905 gram.	B 5 weighed 0.3005 gram.
A h weighed 0.2900 gram.	B 6 weighed 0.3000 gram.

Average of unprepared .....	0.28843
Extreme difference (A b and A c).....	0.0100
Average of water-proofed.....	0.29845
Extreme difference (B 3 and B 5).....	0.0058

These averages show a gain in water-proofing of 3.13 per cent., a greater increase than was shown by the whole sheets.

The weighings betray a lack of perfect uniformity in thickness as to comparatively large areas, and a nice sense of touch shows even greater local differences. Hence, in making trials of tensile strength, it is important to guard against comparing a thin part of one sheet with a thick part of another sheet. In fact, I found some earlier results so obviously erroneous that they had to be rejected, and was thus led to investigate more closely the matter of thickness.

3. Pieces nine millimeters wide in the narrowest part were cut out by pairs and weighted to breaking.

Water-proofed, 1 took 2,784 grams.

Unprepared, 1 took 1,700 grams.

Water-proofed, 2 took 2,098 grams.

Not water-proofed, 2 took 1,652 grams.

Water-proofed, 3 took 2,940 grams.

Not water-proofed, 3 took 2,260 grams.

Water-proofed, 4 took 3,005 grams.

Not water-proofed, 4 took 2,150 grams.

4. Some pieces were dampened over night as the paper is dampened for printing, the pairs having been previously cut with a least width of 9 millimeters.



Water-proofed, 5 broke with 1,180 grams.

Not water-proofed, 5 broke with 990 grams.

Water-proofed, 6 broke with 1,100 grams.

Not water-proofed, 6 broke with 699 grams.

Water-proofed, 7 broke with 1,340 grams.

Not water-proofed, 7 broke with 1,015 grams.

5. Some fine siftings of anthracite-coal ashes were mixed in a Wedgwood mortar, with water, to a thin mud, and equal-sized pieces of the currency were together pounded gently in it for ten minutes; another pair of pieces was pounded fifteen minutes; another pair was bruised in the mud ten minutes; another pair was bruised twenty minutes. In all these cases, the water-proofed piece resisted the severe trial far better than the unprepared piece.

6. A pair of pieces, weighing respectively 0.6130 gram and 0.6519 gram, was rolled up diagonally on a common black lead-pencil 2,100 times—1,400 times on a dry surface or between the fingers, and 700 times on a rough, wet fire-brick. They were put alternately face to face and back to back every twenty rollings. The unprepared piece became so far cracked and torn that further rollings would have been unsafe, while the water-proofed piece was little injured. There was no decrease in weight, though both pieces felt thinner than at first.

7. Two pieces of the same size—about 90 by 50 millimeters—were worn separately, for eight days, inside rough woolen stockings, being interchanged every day, and being placed sometimes face up and sometimes face down. They were then kept imbedded in charcoal long enough for purification. Both specimens suffered severely, and there was left of the unprepared paper only one piece more than 25 millimeters square, and that was badly cracked; while there were still two large pieces of the water-proofed paper in pretty good condition.

8. A pair of pieces was boiled in distilled water sixteen hours. The water-proofed piece was partially split, but otherwise was less injured than the unprepared one. The red stamp of the unprepared piece was considerably dimmed.

9. A pair of pieces was boiled nineteen hours in sea-water, the evaporated fluid being from time to time replaced by sea-water. After two hours' boiling the water-proofed piece split within and puffed up like a bladder. Neither piece was seriously damaged, though the brightness of the red stamp on the unprepared piece was much impaired. The splitting of the water-proofed specimens simply shows that the impregnation had not been absolutely uniform through the entire thickness of the paper.

For want of dog-day weather, it has not been convenient to make any experiments as to relative liability to mold or mildew. There is, however, no reason to suppose that the substances left in the paper by waterproofing is favorable to fungus growths.

Cotton cloth has been known to deteriorate by long keeping, in consequence of the presence of injurious chemicals in the starch used for finishing; and the question might well be asked whether this water-proofed paper can, in time, suffer from the slow action of the substances with which it is impregnated. There are no experimental data with respect to this point, but I do not see how any of the materials used can tend to produce a gradual weakening of the fiber.

To the first question asked by the honorable Secretary, "whether or not there has been any change in the material," I cannot give a positive answer. At the time of making my former trials I had seen no one connected with the Bureau and had not been told what the water-proof-



ing materials were. The impregnating matter in the specimens of paper then sent to me appeared to be such as would result from the application of the chemicals which I found in use at the time of my visit. These materials are the best that the market affords. I think there has been no change.

The other question is, whether I am still of the same opinion as when I made my last report.

The experiments lately made have fully confirmed the opinion which I expressed before, that the water-proofing decidedly improves the currency, and that its use should be continued.

It is not unlikely that slight improvements may be made in the details of the process, but I doubt whether any essentially different method can be devised that would be at once so practicable, efficient, innocuous, and economical.

In conclusion, allow me to express my grateful sense of the courtesy and unreserved frankness which were shown by you and your subordinates in answering all questions relating to the work done under your charge.

Very respectfully, yours,

JOHN M. ORDWAY.

Hon. GEO. B. McCARTEE.

Four cards, containing illustrative specimens of destructive work, are sent herewith.

H. Mis. 163—2







THE PRINTING OF THE SECURITIES OF THE UNITED  
STATES.

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SUPPLEMENTAL QUERIES

OF THE

COMMITTEE ON EXPENDITURES IN THE TREASURY DEPARTMENT,

AND

*Answers thereto from the Treasury Department.*

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APRIL 3, 1876.—Ordered to be printed.

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COMMITTEE ON EXPENDITURES  
IN THE TREASURY DEPARTMENT,  
HOUSE OF REPRESENTATIVES,  
Washington, D. C., May 2, 1876.

The Committee on Expenditures in the Treasury Department on the 18th day of March last submitted certain interrogatories to the Secretary of the Treasury, answers to which were transmitted on the 31st day of March.

The committee submit the following queries required to give them explanation of several of the answers, with the request that the proper parties may answer the same in writing, and at as early a day as possible.

In answer to the first question—

A. State if \$2,080,278.38 is the total cost of the work executed in the Bureau of Engraving and Printing during the fiscal year ended July 1, 1875; if not, state what the total cost was.

B. State the total cost of the work on same done outside the bureau.

C. State whether other appropriations were charged, or are to be charged, for the work costing respectively \$568,409.74 and \$11,566.03; also the amount debited or to be debited to each of such appropriations, and annex copies of the items of each of such appropriations as they are entered on the books of the bureau.

In further answer to the ninth question—

A. Give the receipts, deliveries, and balances of paper for the United States notes and fractional currency by the Treasury Department during each of the fiscal years of 1874, 1875, and 1876.

B. Give the receipts, deliveries, and balances of paper partly printed by the Bureau of Engraving and Printing during the same years.

In further answer to the tenth question—



A. Give the number of complete impressions of United States notes, fractional currency, bonds, and stamps on hand at the close of the fiscal years of 1874 and 1875 and at the present time.

B. Give the number of incomplete impressions for the same time.

In answer further to the sixth question—

A. Give the actual number of employes in the bureau for each month for the year ended July 1, 1870, and also for the year ended July 1, 1875, and the pay-rolls for each division of same years.

B. State if the pay-rolls give the amount paid for irregular work, and if there are any payments on vouchers for services rendered or work performed, and not entered on the pay-roll; and if so, please give a memorandum of all such sums paid since July 1, 1875.

In further answer to the twenty-second question—

✓ Please annex copies of all the correspondence, letters, and replies (not already furnished to the committee of which I am chairman) between the Department, or any bureau thereof, and Messrs. Hilgard, Chandler, and others, the committee referred to in answer to this question.

Very respectfully, &c.,

SMITH ELY, JR.,

*Chairman Committee on Expenditures in Treasury Department.*

Hon. B. H. BRISTOW,  
*Secretary of the Treasury.*

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TREASURY DEPARTMENT, June 19, 1876.

SIR: I transmit herewith answers of this Department to the supplementary questions submitted by you on the 2d ultimo.

Very respectfully, &c.,

B. H. BRISTOW,  
*Secretary.*

Hon. SMITH ELY, Jr.,  
*Chairman Committee on Expenditures in the  
Treasury Department, House of Representatives.*

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*Answers to supplementary queries submitted by the Committee on Expenditures in the Treasury Department of the House of Representatives May 2, 1876.*

#### ANSWERS TO QUERIES SUPPLEMENTARY TO QUERY No. 1.

A.—The sum of \$2,080,278.38 is the aggregate cost of all work in connection with engraving and printing during the fiscal year 1874-'75, both within and without the Bureau of Engraving and Printing.

The expenditures on account of engraving and printing in the Bureau of Engraving and Printing during said year, including labor, material purchased, and expenditures on account of engravers' dies, rolls, &c., were \$922,042.43.

B.—The expenditures on account of engraving and printing outside the Bureau of Engraving and Printing during said year were \$578,259.17.

C.—The proper appropriations and accounts were charged on the books of the Bureau of Engraving and Printing with items amounting, during that year, to the sum of \$563,409.74, being cost of work, &c., executed by said bureau. The bills for this work were promptly rendered and submitted to the proper officers of the Department for examination and settlement. These accounts were all adjusted prior to the closing of the books for the fiscal year, and the entire amount has been credited



to the appropriations for the work of engraving and printing. Schedules showing the items in detail charged to each account are annexed, numbered 1 to 31, inclusive.

The proper appropriations and accounts were charged on the books of the Bureau of Engraving and Printing with items amounting to the sum of \$11,566.03, being the cost of work executed by said bureau. The bills for this work were promptly rendered and submitted to the proper officers of the Department for examination and settlement; the accounts were adjusted when the books were closed for the fiscal year. Schedules showing the items in detail charged to each account are annexed, and are marked A to G.

ANSWERS TO QUERIES SUPPLEMENTARY TO QUERY No. 6.

A.—For number of employes in the Bureau of Engraving and Printing during each month of the years ended June 30, 1870, and June 30, 1875, see table No. 1. For pay-rolls of each division for each month of same years, see tables numbered 2 and 3.

B.—The pay-rolls include the amount paid for all work done for the Bureau of Engraving and Printing during the periods specified; and there are no payments made on vouchers which are not so included.

ANSWER TO QUERIES SUPPLEMENTARY TO QUERY No. 9.

A.—See table marked 4.

B.—See tables marked 5 and 6.

ANSWERS TO QUERIES SUPPLEMENTARY TO QUERY No. 10.

A.—Number of impressions of United States notes, fractional currency, bonds, and stamps on hand, completed: June 30, 1874, 418,865 sheets; June 30, 1875, 279,500 sheets; March 20, 1876, none.

B.—Number of impressions of United States notes, fractional currency, bonds, and stamps on hand, incomplete: June 30, 1874, 6,891,134 sheets; June 30, 1875, 3,815,109½ sheets; March 20, 1876, 7,027,037 sheets.

ANSWER TO QUERY SUPPLEMENTARY TO QUERY No. 22.

Copies of all correspondence, letters, and replies in relation to the water-proofing process between this Department and all the bureaus thereof, and the commission appointed to investigate the merits of the said process, not heretofore furnished your committee, are herewith submitted.

TABLE No. 1.

*Number of employes in the Bureau of Engraving and Printing during each month of the fiscal years ended June 30, 1870, and June 30, 1875.*

Month.	Year ended June 30, 1870.	Year ended June 30, 1875.	Month.	Year ended June 30, 1870.	Year ended June 30, 1875.
July.....	294	1, 120	January.....	680	1, 129
August.....	316	1, 198	February.....	797	1, 242
September.....	433	1, 235	March.....	844	1, 324
October.....	607	1, 253	April.....	911	1, 288
November.....	595	1, 293	May.....	983	1, 329
December.....	651	1, 312	June.....	889	1, 349



TABLE NO. 2.  
*Recapitulation of the pay-rolls from July 1, 1869, to June 30, 1870.*

	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Miscellaneous employés ..	\$2,805 74	\$3,143 95	\$3,625 94	\$4,137 32	\$4,214 45	\$4,331 00	\$4,748 64	\$4,957 43	\$5,437 25	\$5,583 57	\$6,121 24	\$5,701 28
Engraving division .....	3,498 46	3,474 90	3,497 95	3,960 74	4,080 06	4,334 14	4,532 14	4,071 76	4,530 08	4,584 11	4,736 96	4,584 07
Machine division .....	2,255 44	1,842 20	2,893 37	5,004 81	5,192 19	5,675 92	6,372 37	5,875 90	5,708 02	5,595 69	5,622 44	5,916 70
Revenue-stamp division ..	3,469 64	4,097 40	8,900 26	7,836 75	5,128 45	4,690 52	5,372 05	5,123 22	4,337 83	5,653 81	6,641 09	6,597 78
Sealing division .....	4,306 16	5,069 55	10,904 54	13,872 57	14,564 65	15,174 21	17,350 45	19,009 90	23,925 77	22,138 72	20,709 28	21,112 78
Numbering division .....	671 35	1,977 25	1,264 40	1,826 75	3,507 55	3,742 69	4,187 29	4,278 11	5,048 20	5,386 39	4,607 52	4,993 63
Binding division .....	1,611 95	1,461 95	2,002 35	2,335 45	1,951 10	2,015 95	1,950 00	1,852 50	2,035 00	1,941 27	1,856 96	1,744 02
Separating division .....	1,301 19	2,015 45	4,170 31	5,765 57	6,105 21	6,834 83	6,027 57	4,731 11	5,685 44	6,094 77	5,853 78	5,667 58
Counting division .....	662 41	829 16	1,253 01	1,737 64	1,940 44	2,426 42	2,479 99	2,518 92	2,796 92	2,995 18	3,214 24	3,283 15
Distributing division .....	129 82	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Pressing division .....	856 82	939 82	1,861 85	2,108 82	2,020 11	2,140 07	2,055 99	1,697 62	1,947 50	1,926 64	2,021 64	2,048 52
Plate-printing division .....	.....	687 15	609 17	5,762 92	7,820 66	8,880 94	11,178 34	15,072 92	19,533 98	18,653 62	21,370 59	24,054 50
Ink-mill .....	.....	220 50	260 35	307 42	285 12	297 00	306 10	224 00	285 00	143 34	153 32	278 34
Total .....	21,568 98	24,759 28	41,243 50	54,656 76	56,809 99	60,543 69	66,760 93	69,413 39	81,270 99	80,702 11	82,909 06	85,982 35



TABLE No. 3.

Recapitulation of the pay-rolls from July 1, 1874, to June 30, 1875.

	July.	August.	September.	October.	November.	December.	January.	February.	March.	April.	May.	June.
Office .....	\$1,955 90	\$1,770 10	\$1,827 90	\$2,196 80	\$2,220 70	\$2,327 30	\$2,240 00	\$2,231 20	\$2,432 95	\$2,252 90	\$2,176 30	\$2,345 35
Wachmen .....	2,849 75	3,113 00	3,304 50	3,601 75	3,680 25	3,857 75	3,670 45	3,644 75	4,294 25	3,599 75	4,211 00	4,269 75
Dressing-room attendants .....	828 50	852 50	950 25	1,084 50	959 00	1,029 25	634 75	658 50	825 00	609 00	673 50	684 50
Cleaners .....	852 40	855 00	862 75	908 50	866 75	906 50	561 50	581 00	722 25	636 00	727 00	667 75
Miscellaneous .....	4,712 15	5,164 29	5,121 85	6,334 30	6,493 50	6,761 10	6,198 50	5,880 05	7,475 75	6,768 75	7,246 10	7,290 40
Engraving division .....	5,848 30	5,264 30	5,200 75	6,003 30	5,046 90	5,619 20	4,986 50	4,706 60	5,566 85	5,269 75	5,544 15	5,624 35
Machine division .....	4,969 24	5,113 30	5,222 40	5,321 65	5,088 00	5,554 55	4,727 35	4,438 00	5,158 55	4,046 65	4,434 45	4,215 60
Counting division .....	2,620 60	2,945 60	3,306 00	3,355 25	2,458 75	2,630 10	1,986 15	2,021 70	2,062 00	1,949 60	2,029 40	2,138 55
Wetting division .....	3,027 10	2,934 25	3,055 25	3,407 85	3,167 10	3,348 55	2,477 15	2,654 50	2,914 85	2,642 50	2,819 55	2,780 45
Face-printing division .....	23,064 60	24,086 95	25,310 50	25,283 45	26,756 40	27,441 90	23,640 00	23,036 75	29,355 15	26,004 90	25,665 30	29,217 35
Sealing division .....	1,909 80	5,387 05	7,815 50	7,158 05	3,089 65	5,171 80	7,404 45	6,566 60	7,238 25	8,558 65	9,178 55	7,589 55
Surface-printing division .....	2,940 15	2,874 75	2,797 25	2,573 85	2,595 85	2,878 80	2,480 55	2,569 90	3,140 00	3,102 05	3,143 30	2,966 60
Examining division .....	4,951 70	5,385 00	6,133 35	7,321 70	6,333 70	7,301 00	4,892 65	5,651 75	6,523 30	5,468 35	6,670 40	6,734 15
Drying division .....	3,797 15	3,662 45	3,569 85	3,847 45	3,383 80	4,250 35	3,782 85	3,292 25	3,730 45	3,321 00	3,247 75	3,703 15
Pressing division .....	2,303 50	2,165 95	2,419 20	2,448 70	2,397 05	2,440 90	1,678 85	1,935 45	2,072 70	1,687 60	1,952 35	1,868 05
Numbering division .....	2,583 25	3,586 30	4,938 40	4,987 30	3,504 45	3,988 50	3,344 95	3,569 70	4,165 50	4,102 00	4,198 90	4,019 80
Separating division .....	4,113 10	4,364 25	5,382 90	5,407 30	4,960 20	5,303 20	4,671 70	5,035 35	5,489 60	5,233 60	5,614 25	5,462 90
Perforating division .....	1,721 85	1,674 65	1,570 25	1,540 15	1,404 50	1,495 75	1,054 60	.....	.....	.....	.....	.....
Binding division .....	2,709 40	2,084 50	2,283 50	2,198 85	2,067 75	2,169 40	1,323 45	2,315 75	2,715 80	2,282 75	1,945 70	1,708 75
Store division .....	1,451 80	1,409 65	1,429 00	1,481 00	1,359 60	1,328 50	1,281 05	1,202 05	1,341 40	1,192 10	1,219 10	1,158 00
Custodian and United States sealer employes .....	1,150 55	1,129 50	1,085 15	1,152 55	1,089 60	1,165 35	1,126 40	1,044 55	1,166 05	1,127 20	1,174 60	1,166 55
Check division .....	345 25	339 00	342 50	351 00	331 25	352 00	347 85	292 00	288 00	342 50	338 00	322 50
Engineers, &c., employed in maceration of redeemed securities .....	337 25	334 50	331 75	346 25	330 00	374 75	396 50	353 50	413 55	422 25	446 10	458 25
Total .....	81,043 29	86,496 84	94,260 75	98,311 50	89,584 75	97,756 50	84,908 25	83,681 90	99,092 20	90,619 35	94,654 75	96,352 30



TABLE NO. 4.

*Balances, receipts, and deliveries of blank paper for United States notes and fractional currency during the fiscal years 1873-'74, 1874-'75, and to April 29, 1876.*

	United States notes.	10 cents.	15 cents.	25 cents.	50 cents.
Balance on hand June 30, 1873.....	12,359,276	2,987,501	368,500	4,671,985	2,833,761
Received from manufacturers.....		7,678,000		4,151,000	4,068,000
Total.....	12,359,276	10,665,501	368,500	8,822,985	6,901,761
Delivered.....	3,448,848	6,349,301	338,500	3,236,985	2,919,000
Transferred to account of paper for circulating notes.....	5,458,000				
Total.....	8,906,848	6,349,301	338,500	3,236,985	2,919,000
Balance on hand June 30, 1874.....	3,452,428	4,316,200	30,000	5,586,000	3,982,661
Received from manufacturers.....	10,200,000	5,732,000		1,824,000	1,400,000
Total.....	13,652,428	10,048,200	30,000	7,410,000	5,382,661
Delivered.....	6,286,948	6,538,300		5,787,500	1,234,661
Total.....	6,286,948	6,538,300	30,000	5,787,500	1,234,661
Balance on hand June 30, 1875.....	7,365,480	3,509,900	30,000	1,622,500	4,148,000
Received from manufacturers.....	3,800,000	4,437,003		3,708,004	3,050,003
By transfer from 50 cents.....				4,148,000	
Total.....	11,165,480	7,946,903	30,000	9,478,504	7,198,003
Delivered.....	4,201,018	4,765,927		4,673,130	1,021,804
Transferred to 25-cent paper.....					4,148,000
Transferred to gold-coin-certificate paper.....			30,000		
Balance on hand April 29, 1876.....	6,964,462	3,180,976		4,805,374	2,028,199

TABLE NO. 5.

*Balances of United States notes.*

	\$1s.	\$2s.	\$5s.	\$10s.	\$20s.	\$50s.	\$100s.	\$500s.	\$1000s.
Balance on hand June 30, 1873.....	195,877	7,104	227,868	32,549	72,600				
Received perfect.....	295,593	906,210	203,519	270,208	86,704	112,000	9,949	14,994	6,248
Received mutilated.....	55,735	54,390	5,081	8,687	1,176		1,011	51	28
Total.....	1,547,205	967,704	435,468	311,444	160,480	112,000	20,960	15,045	6,276
Delivered perfect.....	1,389,000	843,000	420,000	257,000	151,000		19,200	4,940	4,900
Delivered mutilated.....	157,305	123,304	15,629	52,734	8,843		1,760	105	128
Total.....	1,546,305	966,304	435,629	309,734	159,843		20,960	5,045	5,028
Balance on hand.....	900	1,400	839	1,710	637	112,000		10,000	1,248
Balance on hand June 30, 1874.....	900	1,400	839	1,710	637	112,000		10,000	1,248
Received perfect.....	5,291,000	3,118,000	122,000			13,075		13,633	
Received mutilated.....	183,000	101,050	2,000		694	1,925		867	
Total.....	5,474,900	3,220,450	124,839	1,710	1,331	127,000		24,500	1,248
Delivered perfect.....	3,954,600	1,738,800	300	900	300	122,300		14,000	1,200
Delivered mutilated.....	302,800	142,450	539	810	1,031	4,700		2,070	48
Total.....	4,257,500	1,881,250	839	1,710	1,331	127,000		16,070	1,248
Balance on hand.....	1,217,400	1,339,200	124,000					8,430	
Balance on hand June 30, 1875.....	1,217,400	1,339,200	124,000					8,430	
Received perfect.....	2,695,000	19,000	614,116	305,000	150,300		31,154		
Received mutilated.....	69,150	2,302	22,884	4,700	1,000		846		
Total.....	3,981,550	1,360,502	761,000	309,700	151,300		32,000	8,430	
Delivered perfect.....	2,454,000	717,000	613,000	133,000	58,000		30,500	8,000	
Delivered mutilated.....	124,525	18,170	34,684	4,809	900		1,500	430	
Total.....	2,578,525	735,170	647,684	137,809	58,900		32,000	8,430	
Balance on hand.....	1,403,025	625,332	113,316	171,891	92,400				



TABLE No. 6.—*Balances of fractional currency.*

	10 cents.	15 cents.	25 cents.	50 cents.
Balance on hand June 30, 1873.....	1, 046, 501	258, 500	360, 500	576, 760
Received perfect.....	6, 210, 499	77, 964	3, 303, 090	3, 482, 461
Received mutilated.....	132, 500	2, 036	79, 395	94, 540
Total.....	7, 389, 500	338, 500	3, 742, 985	4, 153, 761
Delivered perfect.....	6, 137, 000	334, 500	3, 136, 500	2, 356, 500
Delivered mutilated.....	212, 300	4, 000	100, 485	562, 600
Total.....	6, 349, 300	338, 500	3, 236, 985	2, 919, 100
Balance on hand.....	1, 040, 200	.....	506, 000	1, 234, 661
Balance on hand June 30, 1874.....	1, 040, 200	.....	506, 000	1, 234, 661
Received perfect.....	6, 185, 000	.....	5, 505, 000	.....
Received mutilated.....	143, 000	.....	154, 000	.....
Total.....	7, 368, 200	.....	6, 165, 000	1, 234, 661
Delivered perfect.....	6, 242, 000	.....	5, 528, 000	1, 218, 000
Delivered mutilated.....	296, 300	.....	259, 500	16, 661
Total.....	6, 538, 300	.....	5, 787, 500	1, 234, 661
Balance on hand.....	829, 900	.....	377, 500	.....
Balance on hand June 30, 1875.....	829, 900	.....	377, 500	.....
Received perfect.....	5, 150, 825	.....	5, 907, 135	1, 745, 978
Received mutilated.....	103, 025	.....	141, 929	187, 022
Total.....	6, 083, 750	.....	6, 426, 564	1, 933, 000
Delivered perfect.....	4, 538, 500	.....	4, 412, 000	822, 500
Delivered mutilated.....	226, 592	.....	258, 400	199, 304
Total.....	4, 765, 092	.....	4, 670, 400	1, 021, 804
Balance on hand.....	1, 318, 658	.....	1, 756, 164	911, 196

ANSWER TO QUERY SUPPLEMENTARY TO QUERY NO. 22.

*Documents transmitted to the Committee on Expenditures in the Treasury Department of the House of Representatives, June 3, 1876, in reference to the commission on water-proofing, &c.*

1. Copy of interrogatory.
2. George B. McCartee to J. E. Hilgard, 12th July, 1875.
3. J. E. Hilgard to George B. McCartee, 26th July, inclosing list of members of the Academy of Sciences.
4. B. H. Bristow to Joseph Henry, 30th July, referring the water-proofing matter to the Academy.
5. George B. McCartee to J. E. Hilgard, 4th August.
6. J. E. Hilgard to G. B. McCartee, 23d August.
7. B. H. Bristow to J. E. Hilgard, William Sellers, C. F. Chandler, and Henry Morton, 30th August, appointing them a commission.
8. C. F. Burnam to G. B. McCartee, 4th September, authorizing delivery of paper to Hilgard.
9. J. E. Hilgard to H. C. Jewell, 1st September, transmitting maps, &c.
10. H. C. Jewell to J. E. Hilgard, 3d September, transmitting paper.
11. H. C. Jewell to J. E. Hilgard, 6th September, transmitting paper.
12. Joseph Henry to B. H. Bristow, 19th October, in reference to illness of Professor Hilgard.
13. J. E. Hilgard, notes of proposed report of the commission on the water-proofing.



14. J. E. Hilgard to G. B. McCartee, 20th November, telegram.
15. C. F. Conant to Luke Bemis, 20th November, telegram.
16. H. C. Jewell to J. E. Hilgard, 20th November, telegram.
17. C. F. Conant to G. B. McCartee, 23d November, authorizing delivery to J. E. Hilgard of additional paper.
18. G. B. McCartee to J. E. Hilgard, 23d November, transmitting additional paper.
19. J. E. Hilgard to G. B. McCartee, 27th November, acknowledging receipt of paper.
20. B. H. Bristow to J. E. Hilgard, 27th November, transmitting paper sent from Glen Mills.
21. G. B. McCartee to J. E. Hilgard, 29th November, in reference to receipt for paper.
22. J. E. Hilgard to George B. McCartee, 29th November, in reply to last.
23. B. H. Bristow to Joseph Henry, 1st March, 1876, asking that the commission be instructed to render a report at its earliest convenience.
24. B. H. Bristow to H. C. Jewell, 15th March, authorizing delivery of additional paper to Joseph Henry.
25. H. C. Jewell to Joseph Henry, 15th March, in reference to receipt for paper.
26. Joseph Henry to H. C. Jewell, 15th March, acknowledging receipt of paper.
27. B. H. Bristow to Joseph Henry, 23d March.
28. Joseph Henry to B. H. Bristow, 24th March, transmitting statement of J. E. Hilgard.
29. B. H. Bristow to Joseph Henry, 27th April, transmitting report of C. B. Nason.
30. Joseph Henry to B. H. Bristow, 29th April, giving final conclusions in reference to the water-proofing process.
31. Joseph Henry to B. H. Bristow, 29th April, transmitting documents as follows:
  - A. Report of commission.
  - B. Appendix to report.
  - C. Joseph Henry to commission, returning their report for further consideration.
  - D. Reply of commission thereto.
  - E. Remarks by the president of the Academy on reply of the commission.
  - F. Report of John M. Ordway.

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In further answer to the twenty-second question please annex copies of all the correspondence, letters, and replies not already furnished to the committee of which I am chairman, between the Department or any bureau thereof and Messrs. Hilgard, Chandler, and others, the committee referred to in answer to this question.

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TREASURY DEPARTMENT,  
BUREAU OF ENGRAVING AND PRINTING,  
July 12, 1875.

MY DEAR SIR: May I trespass upon your time so far as to ask that you will forward me a list of the members of the National Academy of Sciences.



As I understand the act of March 3, 1863, incorporating the Academy, we are at liberty to refer scientific questions to the Academy; and it is for this purpose that I would be glad to get the names of the members, and of those who are likely to be able to render service at the present time.

I am, with kindest regards, very respectfully, yours,  
GEO. B. McCARTEE,  
*Chief of Bureau.*

Prof. J. E. HILGARD,  
*Secretary, &c., Washington, D. C.*

UNITED STATES COAST SURVEY OFFICE,  
*Washington, D. C., July 26, 1875.*

DEAR SIR: In compliance with a promise made some days since, I send you herewith a list of the members of the National Academy of Sciences, with their specialties marked against their names.

Yours, truly,

J. E. HILGARD.

GEO. B. McCARTEE, Esq.,  
*Chief Bureau Engraving and Printing,  
Treasury Department, Washington, D. C.*

(One inclosure.)

*Members of the National Academy of Sciences, 1875.*

Abbott, Henry L.....	Major U. S. Engineers, (engineering.)
Agassiz, Alexander .....	Zoölogist.
Alexander, Stephen .....	Mathematician, (aged.)
Baird, Spencer F.....	Zoölogist.
Barnard, Frederick A. P....	President Columbia College, N. Y., foreign secretary N. A. S., physics, chemistry, microscopy, (aged.)
Bartlett, Wm. H. C.....	Mathematics and physics, (aged.)
Barnard, J. G.....	Colonel U. S. Engineers.
Brown-Sequard, Chas. E....	Physiologist.
Brush, George J.....	Physics and chemistry.
Chandler, Chas. F.....	Columbia College, president board of health, New York City.
Coffin, John H. C.....	Astronomer.
Cooke, Josiah P., jr.....	Harvard University, chemistry.
Cope, Edward D.....	Natural history, paleontology.
Crafts, James M.....	Mass. Institute Technology, chemistry.
Dalton, John C.....	Physiology.
Dana, James D.....	Yale College, geology, (aged.)
Davidson, George .....	U. S. Coast Survey, astronomy and geog- raphy.
Davis, Chas. H.....	Astronomy, (aged.)
Eads, James B.....	Engineering.
Ferrel, William .....	Mathematics.
Genth, Fredk. A.....	University of Pennsylvania, chemistry.
Gibbs, Wolcott .....	Harvard College, chemistry and physics, president N. A. S.
Gill, Theodore .....	Zoölogy.
Gould, Benj. A. (absent) ...	Astronomer.



Guyot, Arnold	Geology and terrestrial physics.
Hall, James	Geology, New York State geologist.
Hayden, F. V.	Geologist and explorer.
Henry, Joseph	Smithsonian Institution, president N. A. S.
Hilgard, Eugene W.	Chemistry and geology, University of Cal.
Hilgard, Julius E.	Mathematics and physics, home sec. N. S. A.
Hill, George W.	Astronomy.
Humphreys, A. A.	Chief U. S. Engineers.
Hunt, T. Sterry	Chemistry and geology.
Johnson, Samuel W.	Yale College, agricultural chemistry.
Lane, J. Homer	Mathematics and physics.
Lesley, J. Peter	University of Pennsylvania, geologist.
Loomis, Elias	Mathematics and physics, Yale College.
Le Conte, John L.	Natural history.
Lesquereaux, Leo	Paleontology.
Lovering, Joseph	Physics, Harvard.
Lyman, Theodore	Naturalist, Cambridge.
Marsh, Geo. P.	Linguist.
Marsh, O. C.	Paleontology, New Haven.
Mayer, Alfred M.	Physics, Stevens Institute, Hoboken.
Meek, F. B.	Geology, Washington.
Meigs, M. C.	Engineer U. S. A.
Mitchell, S. Weir, M. D.	Physiology.
Morton, Henry	Physics and chemistry, Stevens Institute, Hoboken.
Newberry, J. S.	Geology, Columbia College, New York.
Newcomb, Simon	Astronomy and mathematics, U. S. N.
Newton, H. A.	Mathematics, Yale College.
Norton, Wm. A.	Engineering, Yale College.
Oliver, James E.	Mathematics, Cornell University.
Packard, A. S., jr.	Naturalist, Salem, Mass.
Pierce, Benjamin	Mathematics and astronomy, Harvard.
Pickering, Edward C.	Physics and chemistry, Massachusetts Inst.
Pourtales, L. F.	Naturalist, Cambridge.
Pumpleby, Raphael	Geology.
Rodgers, John	Rear-Admiral U. S. N.
Rogers, William B.	Geology and physics, (aged.)
Rogers, Fairman	Engineering.
Rood, Ogden N.	Physics, Columbia College.
Rutherford, Lewis M.	Astronomy.
Schott, Chas. A.	Mathematics and physics, Coast Survey.
Sellers, William	Mechanical engineering, Philadelphia.
Silliman, Benjamin	Chemistry, New Haven.
Smith, J. Lawrence	Chemistry and mineralogy, Louisville.
Trowbridge, Wm. P.	Engineering, New Haven.
Trumbull, J. H.	Ethnology, Hartford.
Tuckerman, Edward	Linguist, Amherst.
Verrill, A. S.	Botany and zoölogy, New Haven.
Watson, James C.	Astronomy, Ann Arbor, Mich.
Whitney, Josiah D.	Geology, Cambridge.
Whitney, Wm. D.	Philology, New Haven.
Woodward, J. J., M. D.	U. S. A., physiology.
Worthen, A. H.	Geology, Illinois.
Young, C. A.	Astronomy, Dartmouth College.



TREASURY DEPARTMENT, *July 30, 1875.*

SIR: Upon the recommendation of the Banking and Currency Committee of the House of Representatives, and in accordance with the act of Congress of March 3, 1863, I respectfully refer to your academy for examination and report to this Department the secret process of water-proofing patented and controlled by Mr. John M. Williams, of Salem, N. Y., now in use in the preparation of the fractional currency and funded-loan bonds.

I have to request that you will have the matter investigated and decide what is the advantage of this process, and what may seem a fair and just compensation to the patentee.

The operation may be witnessed in the Bureau of Engraving and Printing by any members of your academy whenever it may suit their convenience.

Very respectfully,

B. H. BRISTOW,  
*Secretary.*

Prof. JOSEPH HENRY,  
*President of the National Academy of Sciences,  
Washington, D. C.*

5.

TREASURY DEPARTMENT,  
BUREAU OF ENGRAVING AND PRINTING,  
*August 4, 1875.*

DEAR SIR: I regret that I was not in the office when you called this morning in reference to the water-proofing matter.

I know that while the Secretary does not wish any unnecessary delay, neither does he wish to cause any inconvenience to you or to Professor Henry. If you can fix a day when you can visit the bureau and inspect its workings in the matter in question, I shall be happy to see you. If I am absent, Mr. Jewell will wait upon you and furnish all necessary data.

I am much obliged for your prompt attention.

I am, very respectfully,

GEO. B. McCARTEE,  
*Chief of Bureau.*

Prof. J. E. HILGARD,  
*United States Coast-Survey Office.*

6.

UNITED STATES COAST SURVEY OFFICE,  
*Washington, August 23, 1875.*

I am endeavoring to arrange a meeting of the commission on the water-proofing process for Thursday next. Will that day be convenient to you?

Yours, respectfully,

J. E. HILGARD.

GEO. B. McCARTEE, Esq.

The commission is composed of J. E. Hilgard; C. F. Chandler, New York; William Sellers, Philadelphia; Henry Morton, Hoboken.



7.

TREASURY DEPARTMENT,  
August 30, 1875.

GENTLEMEN: You are hereby appointed a commission to examine and report upon a certain process for water-proofing paper; and for the purpose of indicating as nearly as possible the duties devolving upon you in connection therewith, the following is given for your guidance: The Department desires the commission to report, first, on the usefulness of the process for increasing the durability and security against counterfeiting of notes; second, their judgment as to what would be a just and fair compensation to the patentee, assuming the patent to be valid.

You will be fully informed as to the details of the process, and will consider yourselves under the obligation of secrecy in respect to the same.

Respectfully,

B. H. BRISTOW,  
*Secretary.*

Prof. J. E. HILGARD,  
Prof. WILLIAM SELLERS,  
Prof. C. CHANDLER,  
Prof. HENRY MORTON.

8.

TREASURY DEPARTMENT,  
September 4, 1875.

SIR: For the purpose of making the necessary experiments in testing the usefulness and merits of the water-proofing process now in use in the Bureau of Engraving and Printing, you are authorized and directed to deliver to Prof. J. E. Hilgard, chairman of committee appointed by Department letter of 30th ultimo, twelve (12) sheets of ten-cent fractional-currency paper and four (4) sheets of ten-cent fractional-currency notes, one half of the above to be water-proofed.

Very respectfully,

C. F. BURNAM,  
*Acting Secretary.*

GEO. B. MCCARTEE, Esq.,  
*Chief of Bureau Engraving and Printing.*

9.

UNITED STATES COAST-SURVEY OFFICE,  
Washington, September 1, 1875.

DEAR SIR: I send you herewith some of our maps, which I would like to have water-proofed by your process for the use of the commission, and in conformity with our understanding of this morning. I would ask you to send me six (6) sheets of paper used for fractional currency as it comes from the mill; six (6) sheets of the same water-proofed; two (2) sheets of fractional currency completely printed, one-



half of each cut off before water-proofing, the other after water-proofing. The corresponding halves should be marked.

Yours, respectfully,

J. E. HILGARD.

HENRY C. JEWELL, Esq.,  
*Assistant Chief Bureau Engraving and Printing,  
Treasury Department.*

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10.

TREASURY DEPARTMENT,  
BUREAU OF ENGRAVING AND PRINTING,  
*September 3, 1875.*

SIR: In accordance with the request contained in your letter of the 1st instant, I send herewith six sheets of fractional-currency paper as it comes from the mill; six sheets of the same water-proofed; two sheets of ten-cent fractional currency, completely printed, cut in half longitudinally, and one-half of each sheet water-proofed; two sheets of ten-cent fractional currency completely printed, one of which sheets is water-proofed.

In reference to the maps water-proofed and herewith returned, I beg to say that we are not provided with facilities for water-proofing paper so thin and so large as the maps in question, and that is the cause of the discoloration. With proper facilities for handling, they could be made to receive a very beautiful finish.

The blank fractional-currency paper has become slightly discolored by imprint from the twill of the canvas, but this is not sufficient to mar the brightness of a printed sheet.

I beg leave to call your attention to the fact that the printed paper has been thoroughly saturated with water previous to each of the three printings it has received, and as many times dried in a temperature of 185°, which must have a tendency materially to weaken the fiber, while the plain paper, not having been submitted to these weakening processes, retains its original strength.

Mr. Williams remains here to afford any explanation which may be required by the committee. In view of pressing business engagements elsewhere, he would be obliged if the committee would advise him at what time they desire his presence.

Very respectfully,

HENRY C. JEWELL,  
*Acting Chief of Bureau.*

Prof. J. E. HILGARD,  
*Washington, D. C.*

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11.

TREASURY DEPARTMENT,  
BUREAU OF ENGRAVING AND PRINTING,  
*September 6, 1875.*

DEAR SIR: I send by the bearer hereof the sheets of paper left by you on Saturday. We had some difficulty in water-proofing the very thin bank-note paper, and the tissue-paper could not be handled at all without serious mutilation.



Mr. John M. Williams will be at the Revere House, in Boston, on Wednesday and Thursday, and will communicate to you his address thereafter.

Very respectfully,

HENRY C. JEWELL,  
*Acting Chief of Bureau.*

Prof. J. E. HILGARD, &c.,  
*Washington, D. C.*

12.

SMITHSONIAN INSTITUTION,  
*Washington, October 19, 1875.*

DEAR SIR: Prof. Henry Morton writes, October 15, that Professor Hilgard desires us to inform you of his illness from erysipelas of the head, from which he is now recovering, but which has delayed the presentation of a report on water-proofing.

I have the honor to be, very truly, yours,

JOSEPH HENRY,  
*Secretary Smithsonian Institution.*

Hon. B. H. BRISTOW,  
*Secretary of the Treasury.*

13.

*Notes for report.*

I. As to usefulness of process.

The process used is doubtless of great advantage. The gain is twofold:

1. Durability.
2. Security.

*As to durability.*—The paper loses most of its strength by the repeated wetting and drying for successive printings. By the water-proofing process the sizing is restored; moreover, the ink is covered with a glazing which prevents the speedy soiling of the notes.

The sizing has some peculiarity which renders it less brittle (more pliant) than that usually employed, hence the notes will not crack or break so readily.

*As to security.*—Increased security is obtained by rendering transferring more difficult by permitting the printing to be done on softer paper, producing more perfect impressions; also rendering practicable excellent printing from relief-dies or plates, which are very difficult to counterfeit. This has been heretofore done with the seal, (although not now practiced,) and might to advantage be done with all the color-printing. A large economy in the cost of work appears here practicable. But as it is not now done, we leave it out of consideration.

In order to arrive at some measure of the advantage derived from the use of the water-proofing process, we have estimated, upon data furnished by the Department, that as now used, if the Department were in possession of the process, it could be applied to the whole of the fractional currency now printing for \$50,000 per year.



The whole cost of that currency may be put roughly at \$1,000,000 a year. Assuming now that the duration or life of that currency is increased by one-fourth, which this commission consider a fair estimate, (requiring so much less to be printed,) the gain is \$250,000, leaving \$200,000 clear gain.

A more accurate estimate could be obtained from actual statistics of the duration of fractional currency before and after water-proofing, if the data are extant in the redemption bureau.

II. What is a just and fair compensation to the patentee?

Considerations:

There is nothing in the "Lowery" patents but some special combinations of well-known processes. The process actually carried on is a valuable adaptation of known processes of sizing and using a "mordant" or "pickling," an adaptation to the kind of paper used by the choice and proportions of materials such as are commonly used for such purposes.

Of its precise nature the commission have preferred not to be informed, in order that they might be in a position to advise the Department hereafter as to a suitable process, should circumstances render it desirable.

The patentee does not claim the system or process of sizing (the notes) after printing, which is, in fact, practiced in several arts for a long time. The patentee is entitled to credit for the suggestion, but has no proprietary right in it. Such right resides in the special features (peculiarities) of his process, which we have declared to be very efficient.

But the great saving estimated to arise to Government is from the practice of *sizing after printing*, and satisfactory results could be readily obtained without infringing on the rights of the patentee.

On the other hand the adaptation or "perfecting" of the process, that is to say, the invention in which the patentee has a right, cannot but have involved considerable outlay of time or money on his part, and a great benefit has accrued to the Government, in the way of economy, from the use of his process.

Taking a liberal view of the profits to which an inventor is entitled, we are of opinion that \$50,000 would be a just and fair payment for the free use of his process by the Government hereafter.

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14.

[Telegrams.]

HOBOKEN, N. J., Nov. 20.

GEO. B. MCCARTEE,

*Treasury Department, Washington, D. C.:*

I wish to visit paper-mill Monday. Please telegraph Willcox, Philadelphia. Address to me here and arrange for my admittance.

J. E. HILGARD.

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15.

TREASURY DEPARTMENT, 20th November, 1875.

LUKE BEMIS, Esq.,

*United States Superintendent Glen Mills, Pennsylvania:*

Prof. J. E. Hilgard will visit the mills on Monday next. Allow him to make a full inspection of the premises and of paper on hand.

CHAS. F. CONANT,

*Assistant Secretary.*



16.

TREASURY DEPARTMENT, 20th November, 1875.

Prof. J. E. HILGARD,  
*Hoboken, New Jersey:*

Secretary has telegraphed United States Superintendent Bemis, at Glen Mills, to extend to you every facility for inspecting the paper-mills.

HENRY C. JEWELL,  
*Acting Chief.*

17.

TREASURY DEPARTMENT,  
 November 23, 1875.

SIR: For the purpose of making additional experiments in testing the usefulness and merits of the water-proofing process now in use in the Bureau of Engraving and Printing, you are hereby authorized and directed to deliver to Professor J. E. Hilgard, chairman of the committee appointed by Department letter of the 30th of August last, eight sheets of 50-cent fractional-currency paper and eight sheets of localized-fiber bond-paper, one-half of them to be water-proofed; also one quart of the first and second preparation of water-proofing.

Very respectfully,

CHAS. F. CONANT,  
*Assistant Secretary.*

Mr. GEORGE B. MCCARTEE,  
*Chief of the Bureau of Engraving and Printing, Treasury Department.*

18.

TREASURY DEPARTMENT,  
 BUREAU OF ENGRAVING AND PRINTING,  
 November 23, 1875.

SIR: Agreeable to your verbal request of this morning, I transmit herewith, for the purpose of making additional experiments in testing the merits and usefulness of the water-proofing process now in use in this bureau, the following:

Eight sheets of 50-cent fractional-currency paper, one-half of them water-proofed, marked W.

Eight sheets of localized-fiber bond-paper, one-half of them water-proofed, marked W.

Also, one quart of the first and second preparation of water-proofing.

You will please acknowledge the receipt of these sheets, together with the sheets transmitted to you with bureau letter of the 3d of September last, which receipt will be held by this bureau in lieu of the sheets until their return by you on the completion of your experiments.

Very respectfully,

GEO. B. MCCARTEE,  
*Chief of Bureau.*

Professor J. E. HILGARD,  
*Chairman, &c., Washington, D. C.*



19.

UNITED STATES COAST SURVEY OFFICE,  
Washington, November 27, 1875.

SIR: I have received from the bureau under your direction, for the use of the commission on the water-proofing process, the following Government paper, viz: On September 3, six sheets fractional-currency paper as it comes from the mill; six sheets of the same, water-proofed; two sheets of 10-cent fractional currency, completely printed, cut in half longitudinally, and one-half of each sheet water-proofed; also, on November 23d, eight sheets of 50-cent fractional-currency paper, printed in full, one-half water-proofed, and eight sheets localized-fiber bond-paper, each \$100 bond printed in full, but the place for signatures punched out, &c.

Yours, very respectfully,

J. E. HILGARD,  
*Chairman of Committee.*

GEO. B. MCCARTEE, Esq.,  
*Chief of the Bureau of Engraving and Printing.*

NOTE.—The twelve sheets of blank fractional-currency paper, the receipt of which is acknowledged above, were received from the currency division of the Secretary's Office on a "loose" receipt, which was returned and destroyed on presentation of the original of the above letter December 9, 1875.

THOS. J. SULLIVAN,  
*Accountant.*

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20.

TREASURY DEPARTMENT,  
November 27, 1875.

SIR: I transmit herewith four sheets of 25-cent fractional-currency paper, forwarded by Mr. Luke Bemis, United States superintendent at Glen Mills, Pennsylvania, at your request, the receipt of which please acknowledge.

Very respectfully,

B. H. BRISTOW,  
*Secretary.*

Prof. J. E. HILGARD,  
*Chairman, &c., Washington, D. C.*

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21.

TREASURY DEPARTMENT,  
BUREAU OF ENGRAVING AND PRINTING,  
November 29, 1875.

SIR: In reply to your letter of the 27th instant, may I trouble you so far as to ask that you will correct the acknowledgment of the receipts on the 23d instant, as follows:

Instead of "eight sheets of 50-cent fractional-currency paper," &c., please say: "eight sheets of 50-cent fractional-currency paper, printed in full," &c.; and instead of "eight sheets localized-fiber bond-paper,"

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&c., please say "eight sheets localized-fiber bond-paper, each a \$100-bond printed in full," &c.

Very respectfully,

GEO. B. McCARTEE,  
*Chief of Bureau.*

Prof. J. E. HILGARD,  
*Chairman, &c., Washington, D. C.*

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22.

UNITED STATES COAST-SURVEY OFFICE,  
*Washington, November 29, 1875.*

DEAR SIR: All right. I merely followed copy from the Department letter.

I have an idea that the paper received September 3 was not all 10 cent, but some of it 25-cent sheets; but I followed the transmitting letter. I cannot now verify the fact, but, if you have a doubt about it, I can learn from Professor Morton.

Yours, truly,

J. E. HILGARD.

GEO. B. McCARTEE, Esq.

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23.

TREASURY DEPARTMENT,  
*March 1, 1876.*

DEAR SIR: Referring to my communication of July 30, 1875, I beg to say that, in view of the many contradictory statements in regard to the water-proofing process now used in the manufacture of the fractional currency, I would be exceedingly obliged if you would direct the special commission of members of the Academy of which you are president, to which the investigation of the process was intrusted, to render a report at its earliest possible convenience.

I am, sir, very respectfully, &c.,

B. H. BRISTOW, *Secretary.*

Prof. JOSEPH HENRY,  
*President of the National Academy of Sciences.*

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24.

TREASURY DEPARTMENT,  
*March 15, 1876.*

SIR: For the purpose of making additional experiments in testing the usefulness and merits of the water-proofing process in use in the Bureau of Engraving and Printing, you are hereby authorized and directed to deliver to Prof. Joseph Henry, president of the National Academy of Sciences, four sheets of twenty-five-cent fractional currency.

Very respectfully,

B. H. BRISTOW, *Secretary.*

Mr. HENRY C. JEWELL,  
*Chief of the Bureau of Engraving and Printing,  
Treasury Department.*



25.

TREASURY DEPARTMENT,  
*Bureau of Engraving and Printing, March 15, 1876.*

DEAR SIR: I have respectfully to request that you will sign and return to me, at your early convenience, the inclosed receipt for the two sheets of twenty-five-cent fractional-currency paper handed to you to-day for the purpose of making tests, &c.

I have the honor to be, very respectfully, &c.,

HENRY D. JEWELL,  
*Chief of Bureau.*

Prof. JOSEPH HENRY,  
*Smithsonian Institution, Washington.*

26.

WASHINGTON CITY, D. C.,  
*March 15, 1876.*

SIR: I have to acknowledge the receipt from you, for the purpose of experimenting, of two sheets of twenty-five-cent fractional currency.

Very respectfully,

JOSEPH HENRY,  
*President of the National Academy.*

Mr. HENRY D. JEWELL,  
*Chief of the Bureau of Engraving and Printing,  
Treasury Department.*

MARCH 16, 1876.—Received two additional sheets of twenty-five-cent fractional currency.

JOSEPH HENRY,  
*President National Academy.*

27.

TREASURY DEPARTMENT,  
*March 23, 1876.*

MY DEAR PROFESSOR: I inclose for your information a memorandum of an answer to a question from the Committee on Expenditures in the Treasury Department of the House of Representatives, relative to the appointment by me of the commission to examine into the merits of the water-proofing process.

I would like you to submit it to Professor Hilgard for his consideration, so that if my remembrance of the matter is not strictly in accordance with the facts it may be corrected before it is given to the committee.

Very respectfully,

B. H. BRISTOW.

Prof. JOSEPH HENRY, &c.,  
*Smithsonian Institution, Washington.*



28.

NATIONAL ACADEMY OF SCIENCES,  
*Washington, D. C., March 24, 1876.*

SIR: I complied with your request to submit your communication of the 23d instant to Professor Hilgard, in order that any necessary corrections might be made in that part of it which relates to himself, and the inclosed is a copy of his reply.

In transmitting this document I beg leave to call your attention to the fact that neither the oral statements of Professor Hilgard nor those which he has made in the inclosed communication are to be regarded as the views of the National Academy of Sciences, since all official communications from the association should be transmitted under the name of its president. Professor Hilgard's statements are informal, with a view to give the Department information as to the progress of the investigation and express his individual opinions. The Academy, as such, has not yet made a report on the subject.

The delay in rendering the report to the Department has been, first, on account of the illness of Professor Hilgard, who had the principal direction of the investigation; and, second, on account of my inability to concur in a report which had been made to me by the committee, and which I have returned to them for further consideration.

The subject of the value of the water-proofing process is one of much difficulty, and I am not sure that it can be definitely settled without a trial of the process in actual practice by issuing series of marked notes, water-proofed and unwater-proofed, and noting the date and number of each returned.

I have the honor to be, very truly, yours,

JOSEPH HENRY,  
*President National Academy of Sciences.*

Hon. B. H. BRISTOW,  
*Secretary of the United States Treasury.*

Inclosing—

*Statement of J. E. Hilgard.*

COAST SURVEY OFFICE,  
*Washington, March 23, 1876.*

DEAR SIR: The statement by Secretary Bristow requires correction in a single respect, viz: instead of "principal points of his proposed report which was deduced from his experiments. He stated, as the result of his examination and tests, that he was convinced," &c., it would be more correct to say "which was based upon the evidence obtained from the Bureau of Engraving and Printing. He stated as the result of all the investigations of the committee up to that date" that he was convinced, &c.

The date of the interview referred to was about October 1, before the result of Professor Morton's experiments were known to me. I submitted the anticipated report to the Department because it was apparent that the process cost much more under existing arrangements than it would cost if conducted by the Department.

I had arranged a meeting of the committee for October 12, but in consequence of my being taken violently ill on arriving in New York October 11, nothing was done until November 19, when the committee



met at Hoboken, and their previous ideas as to the unfitness of the process were reversed by the results of the experiments submitted to them by Professor Morton.

It was then agreed that the experiments should be repeated with new samples at Washington and Hoboken, and upon his return, November 21 or 22, Mr. Hilgard communicated to the Chief of Bureau of Engraving and Printing, and immediately afterward to Assistant Secretary Conant, (Mr. Bristow being absent,) the change of view arrived at.

As the first statement had been informal, (Mr. Conant being present,) the second information appeared to me quite sufficient to bar any action in the premises. In fact, none was taken. The commission met again in New York on December 29, and the report as submitted was agreed upon. It was not immediately sent in, because the committee desired, if possible, to suggest a better mode of obtaining the objects aimed at, and numerous experiments with different kinds of "sizing" were made; but the conviction gained ground constantly that nothing could be added to the original strength of the fiber-felting that would materially increase the endurance of the notes. Our report was therefore made without any recommendation as to an improved process, but part of the delay in making the report was owing to this endeavor; a larger part to the effects of my illness.

Yours, respectfully,

J. E. HILGARD.

Prof. JOSEPH HENRY, &c.

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29.

TREASURY DEPARTMENT,  
*April 27, 1876.*

MY DEAR SIR: I inclose for your consideration a copy of the report on the water-proofing process made by Prof. H. B. Nason, of the Polytechnic Institute of Troy, N. Y., received a few days ago.

Very respectfully, &c.,

B. H. BRISTOW,  
*Secretary.*

Prof. JOSEPH HENRY, &c.,  
*Smithsonian Institution, Washington.*

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30.

SMITHSONIAN INSTITUTION,  
NATIONAL ACADEMY OF SCIENCES,  
*Washington, April 29, 1876.*

SIR: I have the honor, in behalf of the National Academy of Sciences, to present the following as my final conclusion of the investigation in regard to water-proofing the fractional currency.

From the different conclusions arrived at by the commission of the Academy from their experiments, by myself from a series of my own experiments, and by other persons to whom the subject was submitted by yourself, I have finally concluded that the question as to the value of the process cannot be satisfactorily determined by factitious experiments of the kind to which the notes have been subjected, but that the only way the truth can be obtained will be by issuing for circulation a



definite and equal number of water and *unwater*-proofed notes specifically marked, so as to be capable of identification after being worn, and noting after a given time the number and condition of each returned.

I have been informed by Mr. Casilear\* that the plan above suggested would be entirely practicable if the issue of paper fractional currency were ever resumed.

I am, very respectfully, your obedient servant,

JOSEPH HENRY,

*President National Academy of Sciences.*

Hon. B. H. BRISTOW,

*Secretary of the United States Treasury.*

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31.

NATIONAL ACADEMY OF SCIENCES,

*Washington, April 29, 1876.*

SIR: In addition to the report as to my conclusions, in behalf of the National Academy of Sciences, of this date, in regard to the question of the value of the water-proofing process employed in the manufacture of the fractional currency, I have the honor to transfer herewith to the Department the following documents connected with the subject:

A.—Report of the committee of the National Academy.

B.—Appendix to this report.

C.—Letter addressed by me to the commission above mentioned, returning the report for further consideration.

D.—Reply of the commission to my letter.

E.—Remarks by myself on this reply.

F.—Report of Professor Ordway, referred to me by the Department.

G.—Remainder of the sheets of currency (*viz*, 18 fifty-cent notes and 29 twenty-five-cent notes) furnished for the examination.

I have the honor to be, very respectfully, your obedient servant,

JOSEPH HENRY,

*President National Academy.*

Hon. B. H. BRISTOW,

*Secretary of the Treasury.*

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A.—REPORT.

The undersigned, having been appointed a committee to investigate and report upon the usefulness of a certain process of water-proofing, in respect to its increasing the durability and security against counterfeiting of notes, and to give their judgment as to what would be a just and fair compensation to the patentee, assuming the patent to be valid, proceeded to witness the process as applied to the fractional currency, and to gather information on the subject.

They met at Washington on the 30th of August, 1875, and received from the Chief of the Bureau of Engraving and Printing full explanations as to the process in question, and as to all matters concerning its cost, its presumed usefulness, and the entire process of manufacturing the currency.

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\* Of the Bureau of Engraving and Printing.



They also procured copies of the patents upon which the process was stated to be based, and examined into their history.

On inquiry whether the bureau of redemption could furnish data upon which to base an estimate of the advantages of the water-proofing process, by comparing periods before and after its use, the committee were informed that such data were not attainable. They were therefore obliged to resort to the experimental way of forming an estimate of the increased durability. To this end they were furnished with samples of the paper upon which the currency is printed, part of which had been and part had not been treated by the water-proofing process, and of printed currency notes complete, water-proofed and not water-proofed.

The report made by Prof. John M. Ordway to the Bureau of Engraving and Printing, dated January 14, 1875, on the same subject, was likewise communicated to the committee.

Upon the first aspect of the question, there appears much to recommend the process. The water-proofed notes are manifestly stronger than those not so treated. The animal sizing or coating of gelatine given to the paper in its manufacture, is deprived of much of its coherency by the repeated wetting and drying to which it is subjected during the several printings of the notes. It is a fact well known in the manufacture of paper that such sizing loses its strength by repeated solution and resetting. The plan of applying a final sizing after printing the notes—for the water-proofing process may be properly so called—would therefore naturally commend itself to those having charge of the work.

Sizing after printing is, in fact, a process not infrequently employed in the typographical and chromatic arts. In such cases, however, the question of subsequent wear, such as a currency note is subjected to, has not come into consideration.

It was, moreover represented to the committee by the bureau, that a great saving might be effected in the cost of manufacturing the currency by using surface-printing (*i. e.*, printing from dies in relief, on ordinary type-presses) for the back and seal, instead of plate-printing as done at present, under requirement of law. In such case, it would be desirable to have less surface-sizing on the paper in the first instance, in order to give the surface-impressions greater perfection, while the water-proofing process would afterward supply the requisite finish. The committee entirely agree with the bureau in considering that plan as affording at least as great protection against counterfeiting as the three plate-printings now used.

The cost of printing one thousand sheets of the back by the plate-process is said to be \$20; the same by surface-printing would be \$5.75; difference, \$14.25. The cost of plate-printing the seal on one thousand sheets is \$21; the same by surface-printing would be \$4.68; difference, \$16.32. It would appear, then, that if surface-printing were adopted, a saving of \$30 per thousand sheets, amounting to \$375,000 per year, might be effected; and if the water-proofing process were shown to be, as it is believed to be by the chief of the bureau, an essential part of that process, its usefulness would appear to great advantage.

In instituting the experiments on the comparative durability of the notes water-proofed and not so treated, the committee were led by the foregoing considerations to entertain little doubt as to some actual advantage of the process, and aimed at finding some measure of the increased durability upon which to base an estimate of its value. For if the endurance of the currency were found to be increased 20 per cent., for instance, the gain by the process might fairly be estimated at one-fifth of the annual expense of its manufacture.



In connection with this line of inquiry the committee found that the cost of such a process, if conducted by the Department without regard to any patent, would probably not exceed \$4.10 per thousand sheets, or \$53,000 per year, on the actual scale of work in 1875. Their estimate is appended.

The committee, after having held conferences in New York, on September 4, and in Philadelphia, on September 17, met again at the Stevens Institute for the purpose of making their report—the experiments undertaken by Professor Morton having been completed. These experiments were designed to test the effects of the water-proofing process by comparing the strength and resistance to moisture of water-proofed and unwater-proofed notes, first when fresh and unworn, and again after being subjected to a systematic wear as nearly equal as possible, and resulting in putting the notes in a condition similar to that when about half worn in ordinary circulation. The precise manner in which the wear was effected is stated in the appended summaries of experiments, and is substantially the same as that adopted by Professor Ordway, which appeared to imitate the effect of ordinary wear as nearly as could be done by systematic treatment. In fact, the object of the present investigation being to determine the practical value of the water-proofing process, when applied to the fractional currency under the conditions present in its actual use in circulation, and not to develop all the differences that might be discovered under any unusual conditions between the water-proofed and untreated notes, it was necessary to select such tests and modes of treatment as would most nearly realize the conditions and qualities present and required in actual use. One of the most manifest requirements of a note is that it should endure, with as little loss of strength as possible, such foldings, rollings, and crumplings as these notes are constantly subjected to in their daily use.

A series of numerous and exact comparisons were therefore instituted between both kinds of notes simultaneously rolled, folded, and, in some cases, crumpled, not to the destruction of both or either, but to the point when they were in a condition, as the attached specimens show, equal to the average of those found in circulation. The tensile strength of the notes both before and after this treatment was carefully determined by the use of accurate apparatus, and upon a large number of specimens, so as to eliminate any error which would be very likely to arise from accidental differences in structure when only a few notes were employed. In several series of experiments the thickness of each specimen was also accurately measured, and the results were reduced to equal areas.

That the tensile strength is the actual measure of the durability of the note is manifest if we reflect that the final destruction of the note comes when this gives way; in other words, when, in spreading or straightening out, the note separates into two pieces.

The water-proofed and unwater-proofed notes do not differ much in appearance; the former are somewhat more glossy; the water-proofing doubtless at first serves to protect the ink from abrasion. It is questionable whether it serves to keep the note cleaner, for it is somewhat sticky. In the manipulation for artificial wear much more of the ink of the water-proofed notes adhered to the fingers, and they presented a sensibly dingier appearance, than the unwater-proofed. The result of the experiments made upon the 10-cent and 25-cent notes furnished to the committee was substantially *that the water-proofed notes possess no sensible advantage over those not so treated*. When fresh and unworn they are about 20 per cent. stronger than unwater-proofed notes, but



after an amount of wear that still leaves them in good condition for circulation, there is no difference in favor of the water-proofed notes. Moreover, their resistance to water is scarcely increased by the water-proofing process, even in quite new notes.

This result being quite unexpected, although not difficult to explain with the aid of the experience gained, it was deemed best to procure a fresh supply of samples, and to experiment upon them in different ways by different persons.

A supply of 50-cent notes was therefore obtained from the Department, and subjected to tests, part at the Stevens Institute of Technology, and part at the Coast Survey Office in Washington. Mr. Hilgard, who is an expert in the art of paper-making, at this time visited the mill where the paper for the currency is made, and found that the material used and the preparation of the fiber, as well as the sizing in the pulp, are performed according to the best methods known. Nor is the subsequent sizing of the main sheet with gelatine performed in a less satisfactory manner; but the degree to which this latter process should be carried is a matter requiring special consideration and experiment, in view of the facts developed by the experiments of the committee. In consideration of the greater facility and better effect of printing on less strongly-sized paper, and of any deficiency in sizing being supplied by the final water-proofing process, the Chief of the Bureau of Engraving and Printing had directed the amount of size used in making the paper to be greatly diminished, since the inquiries of the committee commenced, and the 50-cent notes furnished for the second series of experiments were in that respect different from the notes first supplied.

But the fact remained equally well marked in both series, viz: *That while the water-proofing process produces an immediate increase of strength of about 20 per cent., that advantage entirely disappears after a certain amount of wear, which still leaves the note in good condition for circulation.* With the experience gained by the experiments, this result, which was not anticipated, is readily explained.

The effect of the water-proofing or sizing process, after the completion of the note, is to cover it on both surfaces with a continuous film of a substance which has considerable resistance to extension, and therefore largely increases the tensile strength of the notes while that film remains continuous. But being brittle, whenever it is broken by folding the entire advantage of its strength is lost, and a definite line of weakness is established, along which the original strength of paper-felt alone resists separation. The common experience of a sheet of letter-paper breaking along its fold, however hard and perfect its surface may be, illustrates this view. We are therefore led to the conclusion that the endurance of a note will depend mainly upon the strength of the paper as made from the pulp, and is not increased by any subsequent surface treatment. It might be objected to this reasoning that the processes in question penetrate the whole thickness of the paper, and thus increase the resistance of the fibers to sliding upon each other, while perhaps not greatly increasing the actual strength..

This is doubtless true of the so-called "engine-sizing," which is the rosin-size mingled with the paper-pulp, which is insoluble in water after being precipitated by alum; but it is not true of the gelatinous size, which, as the paper dries, is carried to the surface with the moisture, and finally is deposited as a hard film on the outside. The familiar fact that highly-finished letter-papers with a very hard surface, that strongly resists an erasure, still permit the ink to *run* when that surface is once



broken, illustrates this view. Ledger paper and drawing-papers, that are to admit of writing after erasure, require extremely slow drying, at low temperature, in order to secure the setting of the glue in the web of the fiber. No process of rapid drying at high heat can yield more than a surface-deposit of the sizing employed.

Apart from the fact that the water-proofing process adds nothing to the wear of the notes, the experiments have developed a notable difference in strength of the paper in transverse directions. This is a familiar property of all machine-made paper. The fibers which form the paper-felt necessarily lie, on the average, at more acute angles in the direction of the continuous sheet than transversely, and consequently a lengthwise strain which would cause a fracture across the sheets meets with greater resistance than a transverse strain. The experiments show that difference to be in the rates of 5 to 8. This difference in strength is unavoidable in machine-made paper. Hand-made paper, where each sheet is felted separately in a form, does not exhibit this difference, but that process is not admissible for the large amount of paper required; moreover, while hand-made paper may be readily imitated on a small scale, the machine-made paper of the Department has properties that cannot be readily reproduced by appliances inferior to those employed.

Care should, therefore, be taken to so print the notes upon the paper that the greatest resistance be opposed to the strain to which they are most exposed in common use. The reverse is the fact in regard to the fractional-currency notes, as actually printed. A material gain in their endurance may be expected from due attention to this condition. This, however, would require that the streaks of "localized fiber" should occur much oftener in the width of the sheet, and should be narrower than at present. In this plan there may be some practical difficulty which the committee do not foresee. If it were adopted the band of "localized fiber" would run lengthwise of each note instead of crosswise, as at present.

It is an open question in the minds of the committee whether it would not be advantageous to omit the gelatine-sizing in the manufacture of the paper and to apply it after the notes are printed; in other words, to substitute the method of sizing *after* printing for that of sizing *before* printing, a question which they would not like to pass upon without special experiments.

At present the paper is charged with animal-size, the strength of which is somewhat impaired by the repeated wetting and drying during the process of printing, and whose presence prevents the final sizing (or so-called water-proofing) from penetrating into the body of the notes.

If the paper were only "engine-sized" the gelatine, applied after printing, would penetrate and produce a condition similar to that of the finished paper as it now comes from the mill. *Slow drying* would, however, be indispensable for a good result, and experiment alone could determine whether the gain in durability would be of more value than the additional cost.

The committee would, however, use the regular glue-sizing employed in the manufacture of paper, and not the saponaceous mixture of the so-called water-proofing process.

This method of proceeding would be particularly adapted to "surface-printing," which, as previously stated, is much less expensive than "plate-printing," and might be used for the back and seal without lessening the difficulty of counterfeiting the notes.

Reports of the experiments conducted by the committee are appended, with specimens of the work.



The foregoing statements dispose of the question of increased durability.

The next question submitted by the Department is that of increased difficulty of counterfeiting the notes. So far as the water-proofing process is concerned, it only increased the difficulty of taking *transfers* by pressure, but since the film produced on the surface of the note can be readily removed by warm water, the obstacle cannot be considered of sensible importance.

In view of the foregoing facts and considerations the committee submit the following conclusions :

CONCLUSIONS.

1. The water-proofing process submitted to the committee increases materially the strength of the notes, while fresh and unworn ; but after a moderate wear that advantage entirely disappears, and the committee cannot perceive that the durability of the notes in actual circulation is materially increased by the treatment in question.

2. The experiments indicate that the effect of the process in making the notes repellant of moisture is scarcely sensible.

3. The advantages of the process in increasing the difficulty of counterfeiting are of no importance.

4. In view of the foregoing conclusions the committee have not thought it necessary to pursue further the question of compensation to the patentee.

5. The committee recommend that, if practicable, the notes be so printed upon the paper that its greatest strength will resist the length-wise strain upon the notes.

J. E. HILGARD.  
HENRY MORTON.  
C. F. CHANDLER.  
WM. SELLERS.

B.—APPENDIX.

*Estimated cost of water-proofing the fractional currency.*

WAGES.	
Number of sheets used per day.....	42,000
Wages of hands per 1,000.....	\$3 20
Wages per day.....	134 40
Add for one foreman or size-maker .....	6 00
Total wages.....	140 40
MATERIAL.	
The weight of paper used is (per day) 546 lbs. The water-proofing increases the weight about 6 per cent. ; hence 33 lbs. of material is actually added to the paper, but much is wasted, and we will assume that five times as much is used, or material used per day .....	
Average cost, (outside estimate) .....	165 lbs. 20 c.
Daily cost of material.....	\$33 00
Daily cost of labor .....	140 40
Total .....	42 ) 173 40
Cost per 1,000 sheets.....	4 10



*Weight of paper, &c., November 15, 1875.*

Plain paper, 100 sheets .....	1 lb.	7 oz.	1 sheet.
Do .....	1	7	
Do .....	1	7	+ 1
Do .....	1	7	+ 1
Do .....	1	7	
Total weight 502 sheets.....	7	3	
Water-proofed paper, 100 sheets.....	1	8½	
Do .....	1	8½	
Do .....	1	8½	
Do .....	1	8½	+ 2 sheets.
Do .....	1	8½	+ 3
Total weight 505 sheets.....	7	10½	
First machine, 100 sheets .....	1	8	— ½ sheet.
Do .....	1	8½	
Do .....	1	8	— ½
Do .....	1	8	— ½
Do .....	1	8	
Total weight 498 sheets.....	7	8½	

NOTE.—The weight of the paper was very uniform. The water-proofing, both processes, increased it by about 6 per cent. The first process alone, or that of sizing proper, increased it about 5 per cent.

STEVENS INSTITUTE OF TECHNOLOGY,  
Hoboken, N. J., February 25, 1876.

*Brief summary of results of experiments on water-proofed and plain currency-notes.*

As the average result of some fifty experiments, I find that there is a gain of about 20 per cent. (exactly 19.49) shown by the water-proofed notes over those not so treated, while both are fresh and unworn.

These tests were made as follows :

Two notes, one water-proofed and one untreated, were taken at random and placed exactly over each other by matching them against the light. They were then laid on a plate of glass, a brass templet pressed firmly upon them, and with a very sharp knife following the edge of the template, two exactly similar pieces were cut from the same parts of each note. This was to secure uniformity as far as the effects of ink and printing were concerned. The two notes were then transposed, the upper one becoming the under, and again matched, and another pair of pieces were cut. These were each distinguished from each other (the water-proofed and unwater-proofed) by a pencil-mark; and when ten pairs of pieces had been so cut, the testing for the strength of the same was then made. This was done in a machine fitted for the purpose by Messrs. Riehle Bros., Philadelphia, and in all respects similar to the machines employed generally for testing tensile strength of materials and fabrics.

The thickness of each piece was measured with a Brown and Sharp micrometer gauge to the ten-thousandth of an inch.

The following table of results will serve as a specimen of this portion of the work :



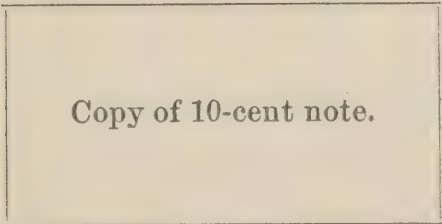
Ten-cent notes.

Number.	Untreated.		Number.	Water-proofed.	
	Thickness.	Strength.		Thickness.	Strength.
	<i>Inches.</i>			<i>Inches.</i>	
1 .....	0.0035	4 11-16	1 .....	0.0030	5 1-4
2 .....	0.0036	4 1-4	2 .....	0.0030	5 1-2
3 .....	0.0035	4 9-16	3 .....	0.0030	5 3-4
4 .....	0.0031	4 5-8	4 .....	0.0032	5 3-4
5 .....	0.0037	4 3-8	5 .....	0.0032	6 1-8
6 .....	0.0032	5 1-8	6 .....	0.0026	4 5-8
7 .....	0.0033	4 3-8	7 .....	0.0035	5 3-8
8 .....	0.0036	5 1-8	8 .....	0.0032	6 5-8
9 .....	0.0032	4 3-4	9 .....	0.0027	6 1-4
10 .....	0.0035	4 5-8	10 .....	0.0031	5 7-8
Means.....	0.00342	4.6375	Means.....	0.00305	5.75

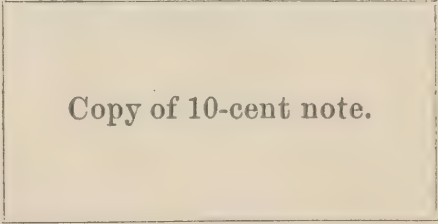
Reduced to equal areas = 5.376 lbs. per square inch.

Reduced to equal areas = 7.419 lbs. per square inch.

When, however, the notes have been worn, as by rolling around a pencil and folding, this advantage entirely disappears, the average of twenty experiments showing a slight advantage for the notes not water-proofed. The amount of wear thus produced was not enough to seriously damage the general appearance and strength of the note, but left it in what would be considered a very sound condition—much better than that of the majority of currency met with in circulation.



Unwater-proofed.



Water-proofed.

The same result followed when the wearing was produced by passing the notes through a crimping-machine, in which case no visible sign of injury was manifest, though the strength of the water-proofed and plain notes was then almost identical, *i. e.*, as 36 to 35.

It seems appropriate to notice in this place that a number of experiments (two sets, of twenty each) made with two sheets of first-class bank-note paper of 1855, one untreated and the other water-proofed, in which the two papers were first tested in fresh state, and then, after wearing as before, showed a much greater loss of strength on the part of the water-proofed paper, as the result of wear, than of the untreated paper. This indicated that with this paper, whose fiber was remarkably good to begin with and properly sized, the additional stiffness given by the water-proofing simply caused a greater injury to the fiber by bending and folding.

The average results were as follows :

Untreated paper.		Water-proofed paper.	
Unworn.	Worn.	Unworn.	Worn.
Strength..... 8.255	7.936	Strength..... 8.803	62.51
Loss by wearing.....	4 per cent.	Loss by wearing .....	31 per cent.



Numerous experiments were then made as to the comparative strength of the paper in the two directions of the sheet, *i. e.*, lengthwise and across, which showed that these differed greatly. Thus, the average of one extended set of experiments made on 50-cent notes, water-proofed, gave:

Lengthwise of sheet, but across the note.....	6.22
Across the sheet, but lengthwise of the note .....	4.20

Fifty-cent notes, plain:

Lengthwise of sheet, but across the note.....	5.80
Across the sheet, but lengthwise of the note.....	3.75

An extended series of experiments was also made as to the absorption of water by the notes, with the following results:

Immersed in water, for 5 minutes, 25-cent and 10-cent notes. Water-proofed notes gained 25 per cent.; unwater-proofed notes gained 25 per cent. Some 50-cent notes sent from Washington, marked "1st machine," showed a gain of 28 per cent. on soaking 5 minutes.

HENRY MORTON.

*Summary of experiments on 50-cent United States currency, to test the effect of the "water-proofing" process, conducted by J. E. Hilgard.*

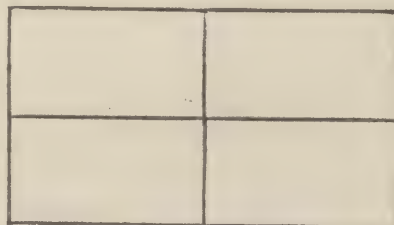
Each note was cut into four pieces—

part of across the note thus:



Marked  
(C.)

part in half, lengthwise, and then  
across, thus:



Marked  
(E.)

Each piece was then accurately cut into this form:



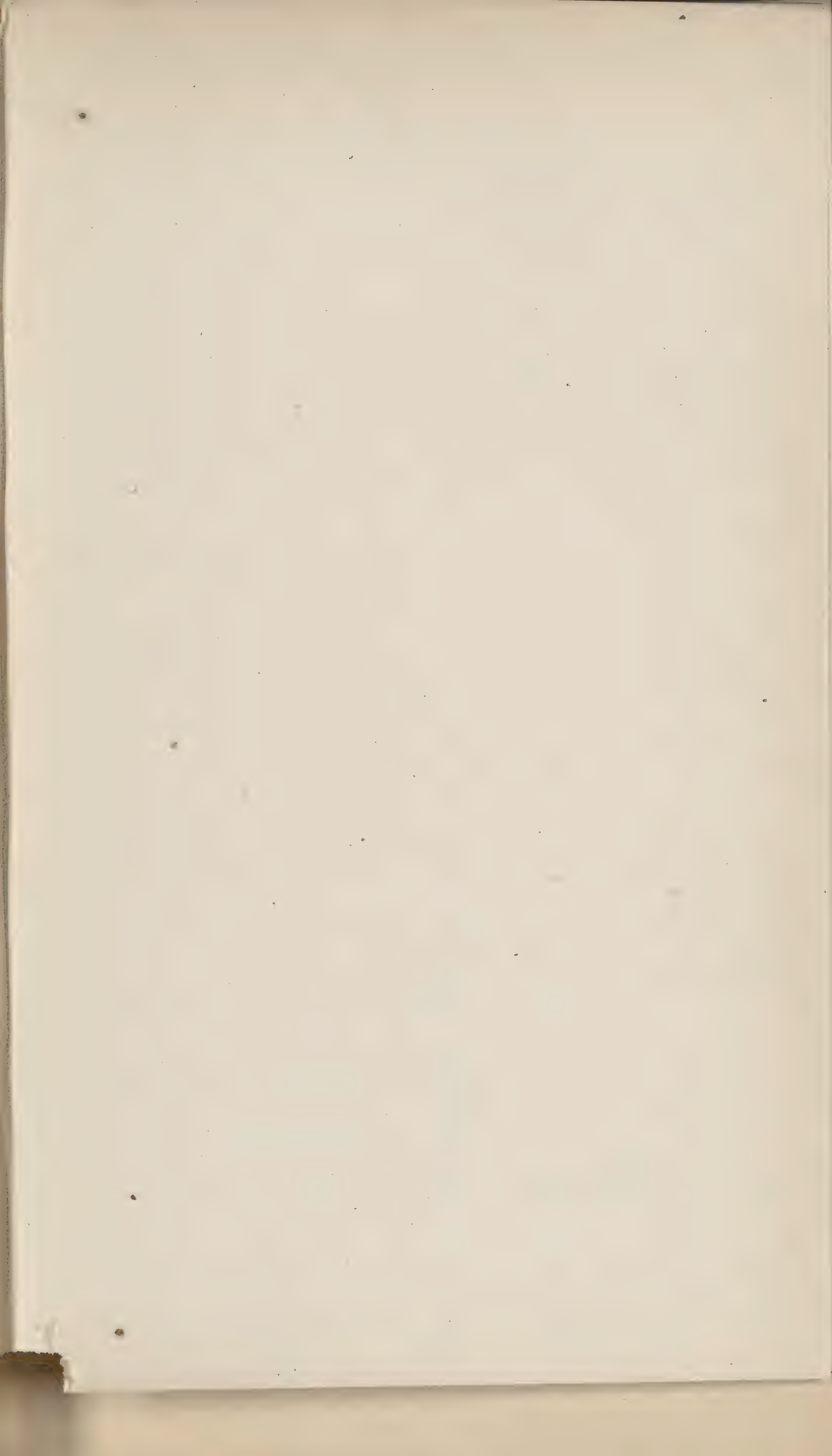
by means of a "templet," and subjected to increasing strain until it broke. Those that had not been subjected to the "water-proofing" process are marked "plain" X; the others, water-proofed, W.

One-half of the notes of each kind were subjected to an artificial wear, by rolling them up on a pencil and flattening the roll down with an ivory edge twice, in diameters transverse to each other. Each note was thus rolled up and creased ten times, face and back outside alternately, lengthwise, crosswise, and diagonally, making 80 rolls and 160 creasings.

After this wear, which was made as uniform as possible for each note, the notes were still in fair condition for circulation, about half worn out, or like the average note met with out of Washington City.

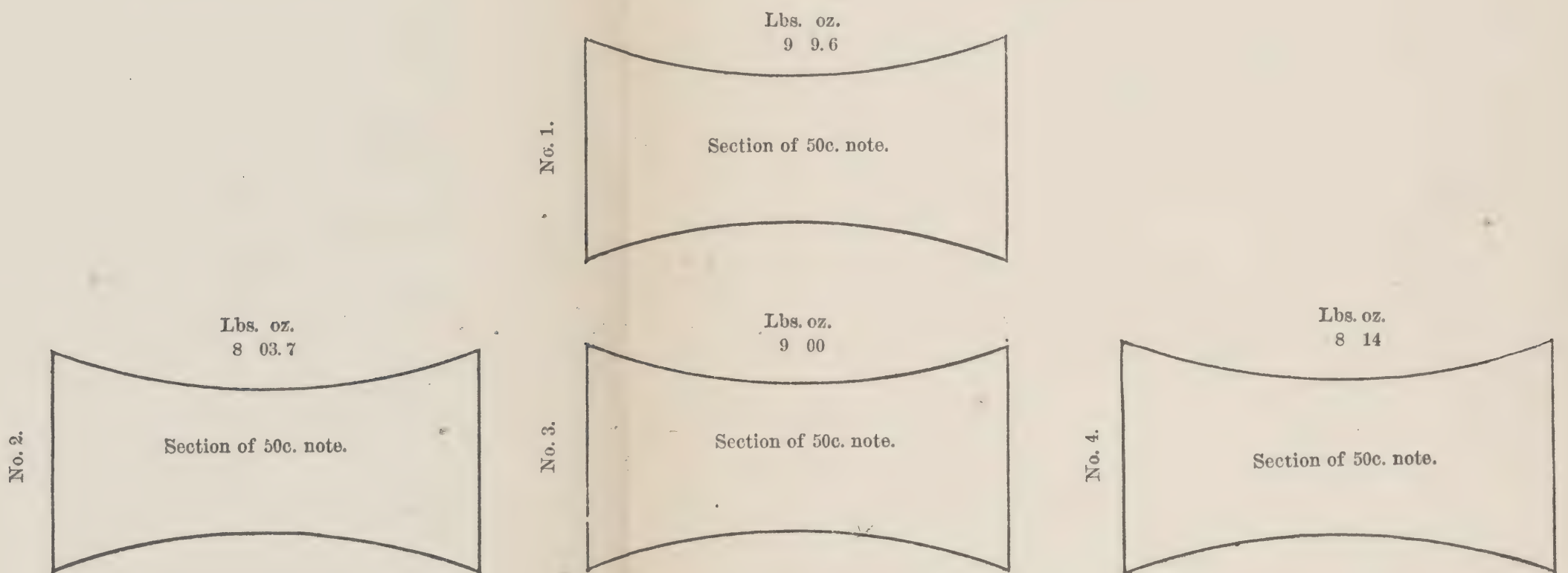
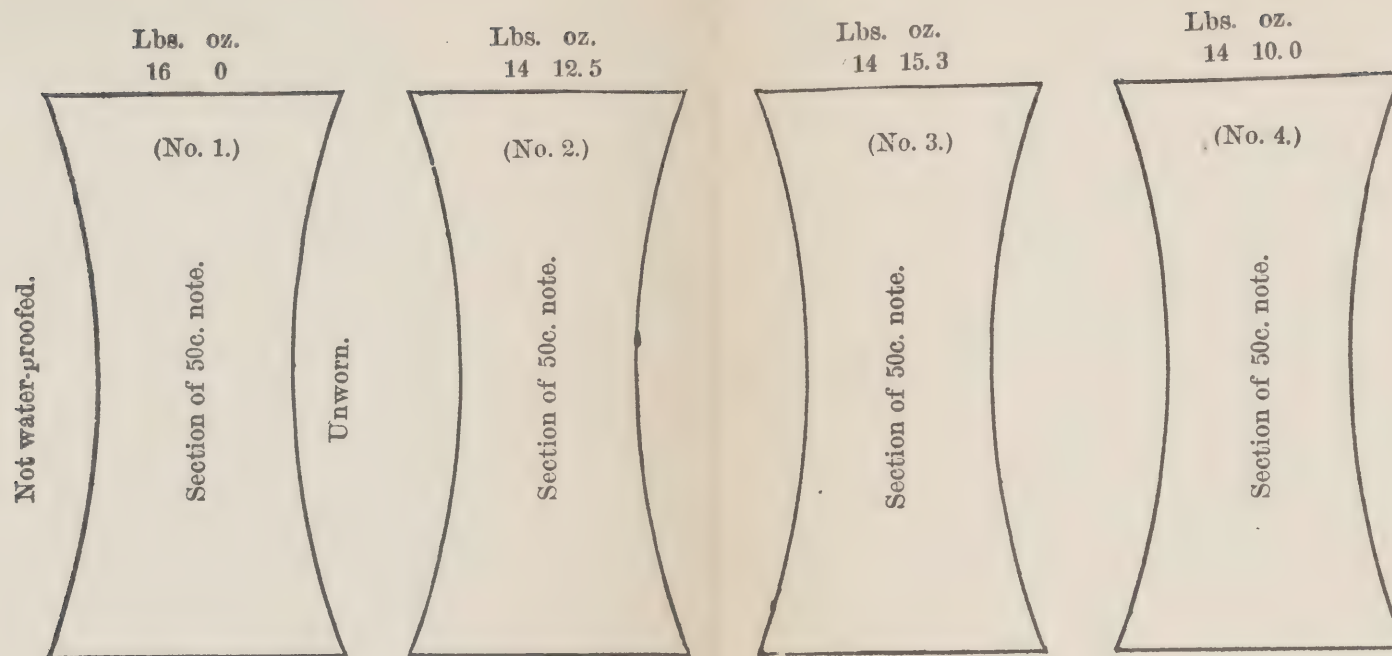
Eight pieces of each kind were used in the experiments for strength, taking the corresponding parts of the several notes, as the strength of the pieces varied somewhat with the amount of black ink upon their face.



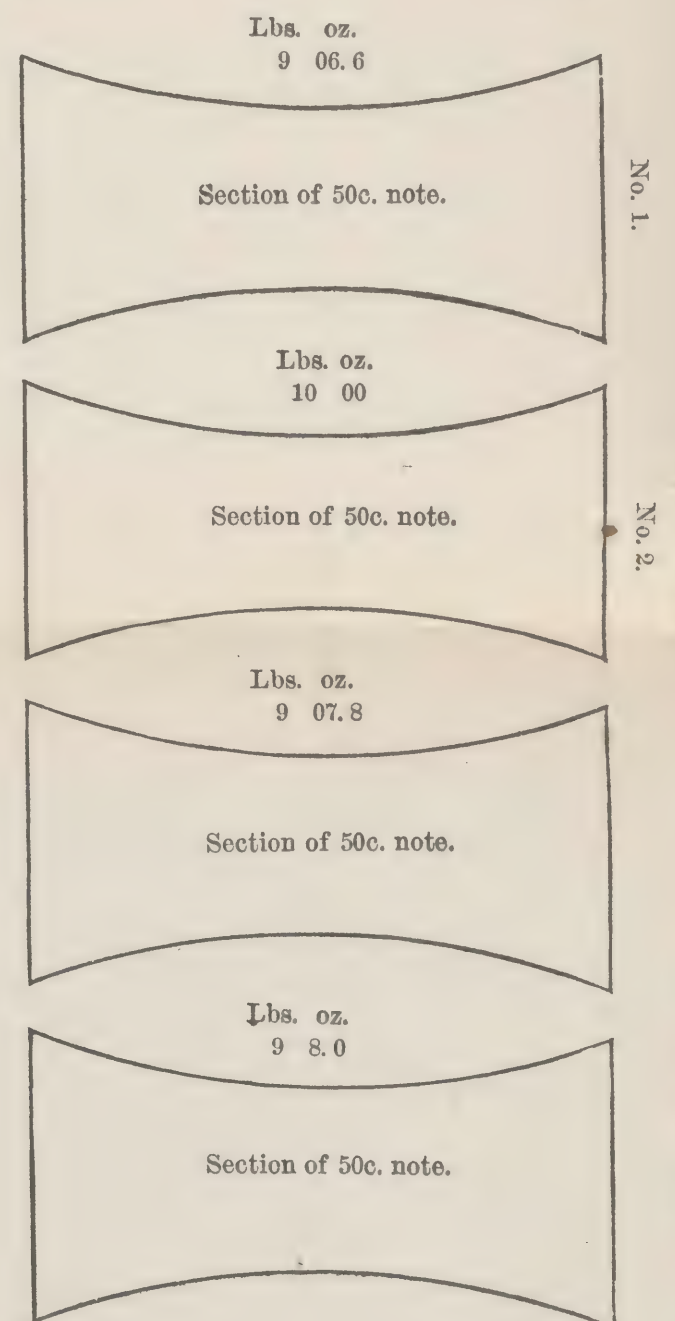
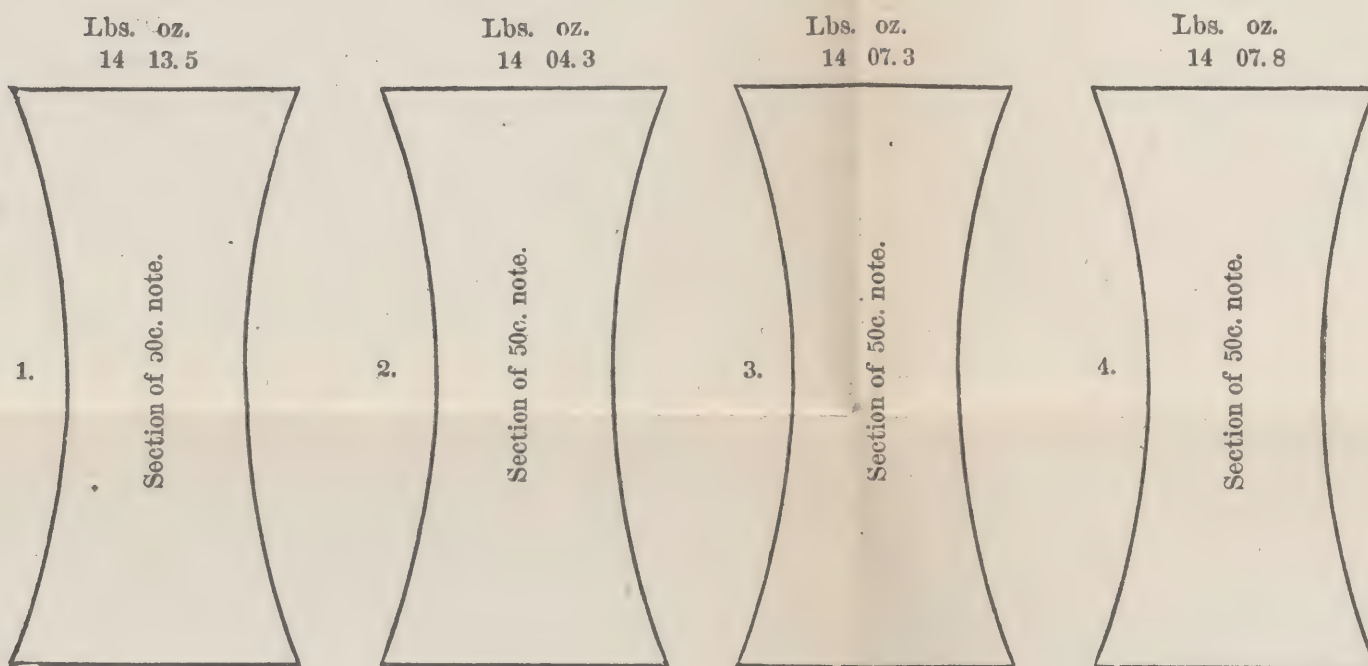




*Unwater-proofed unworn.*

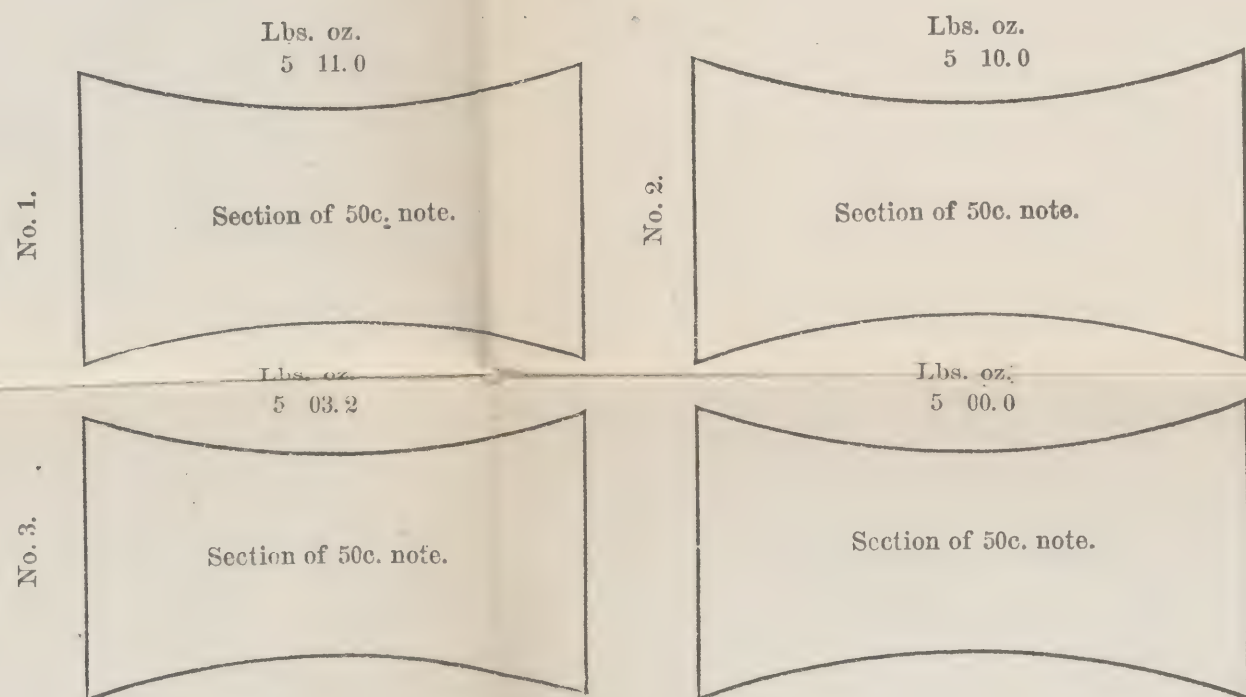
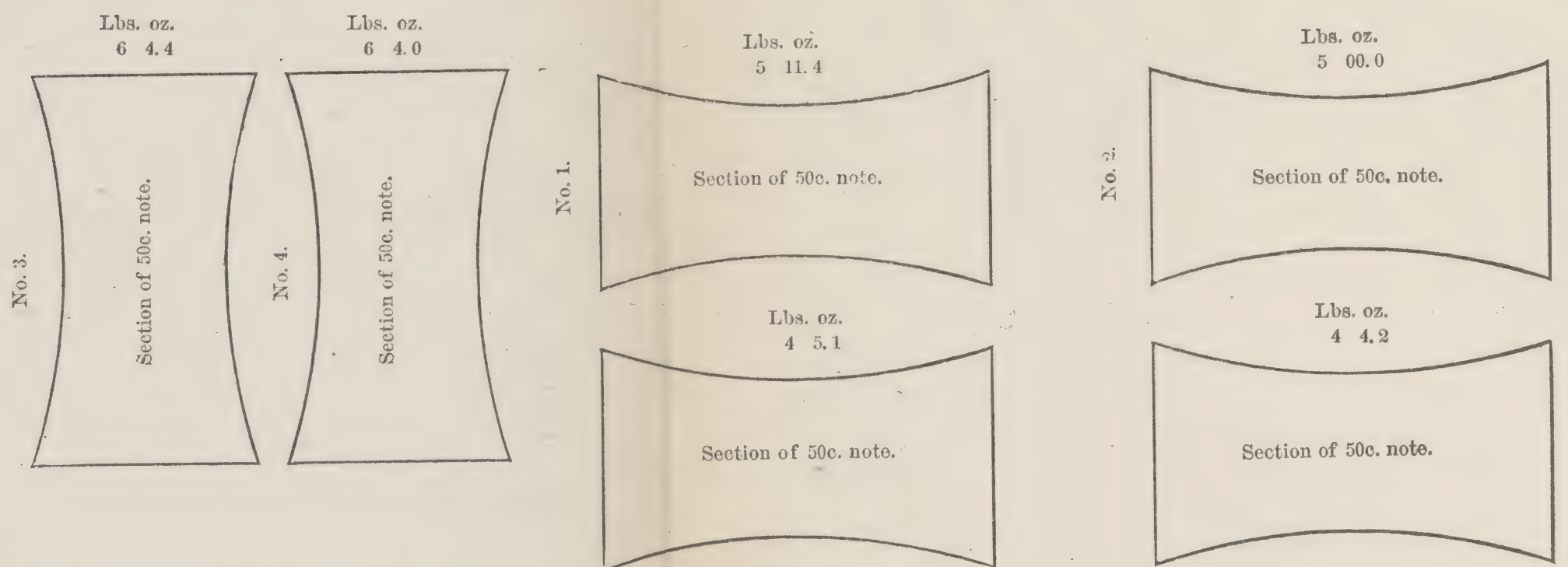
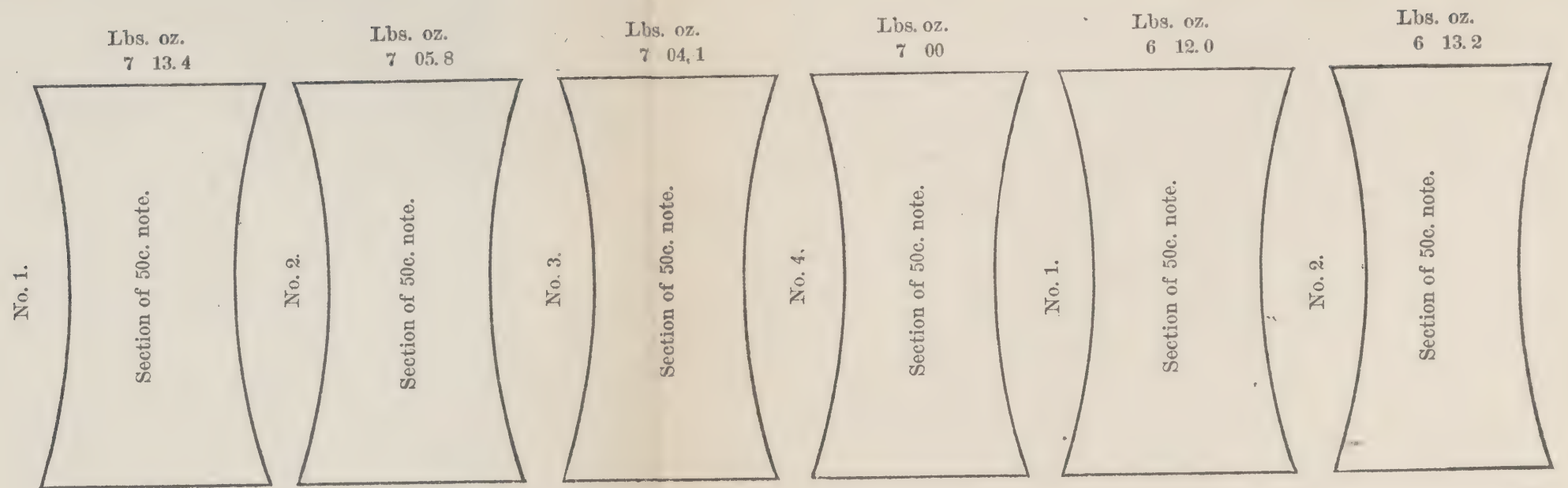


*Unwater-proofed and unworn.*



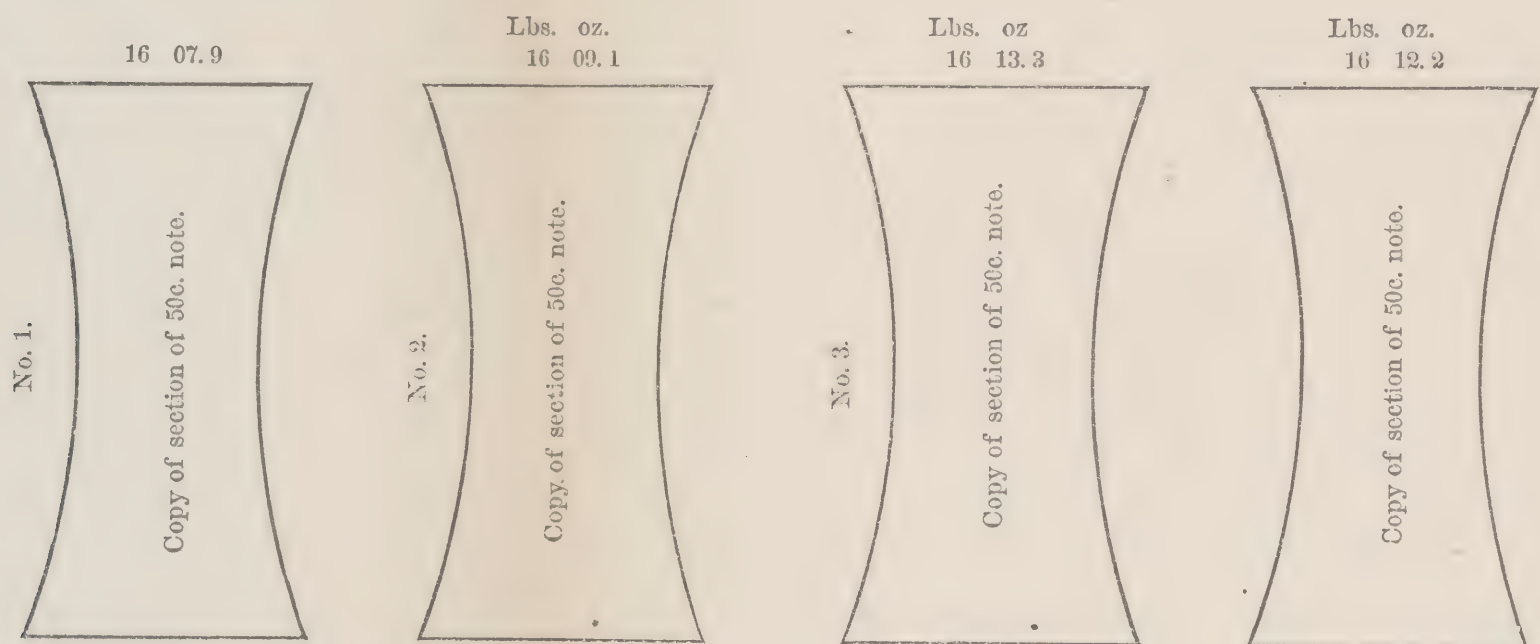
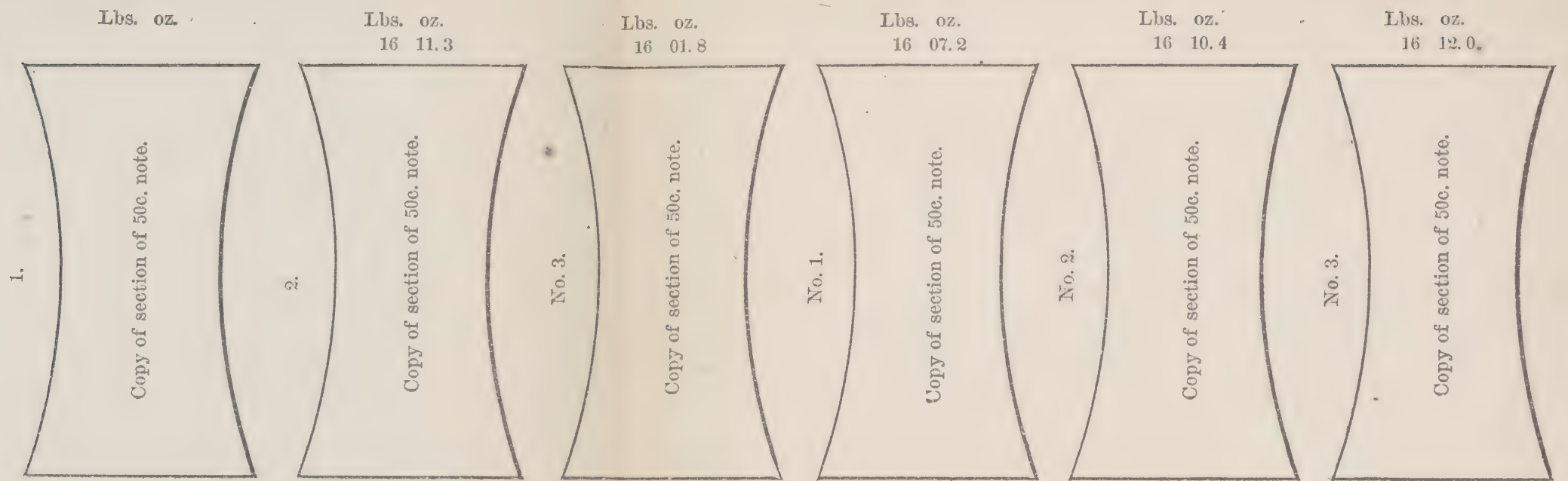


Water-proofed and worn—Formula 11 =  $\times \times$  by 10.

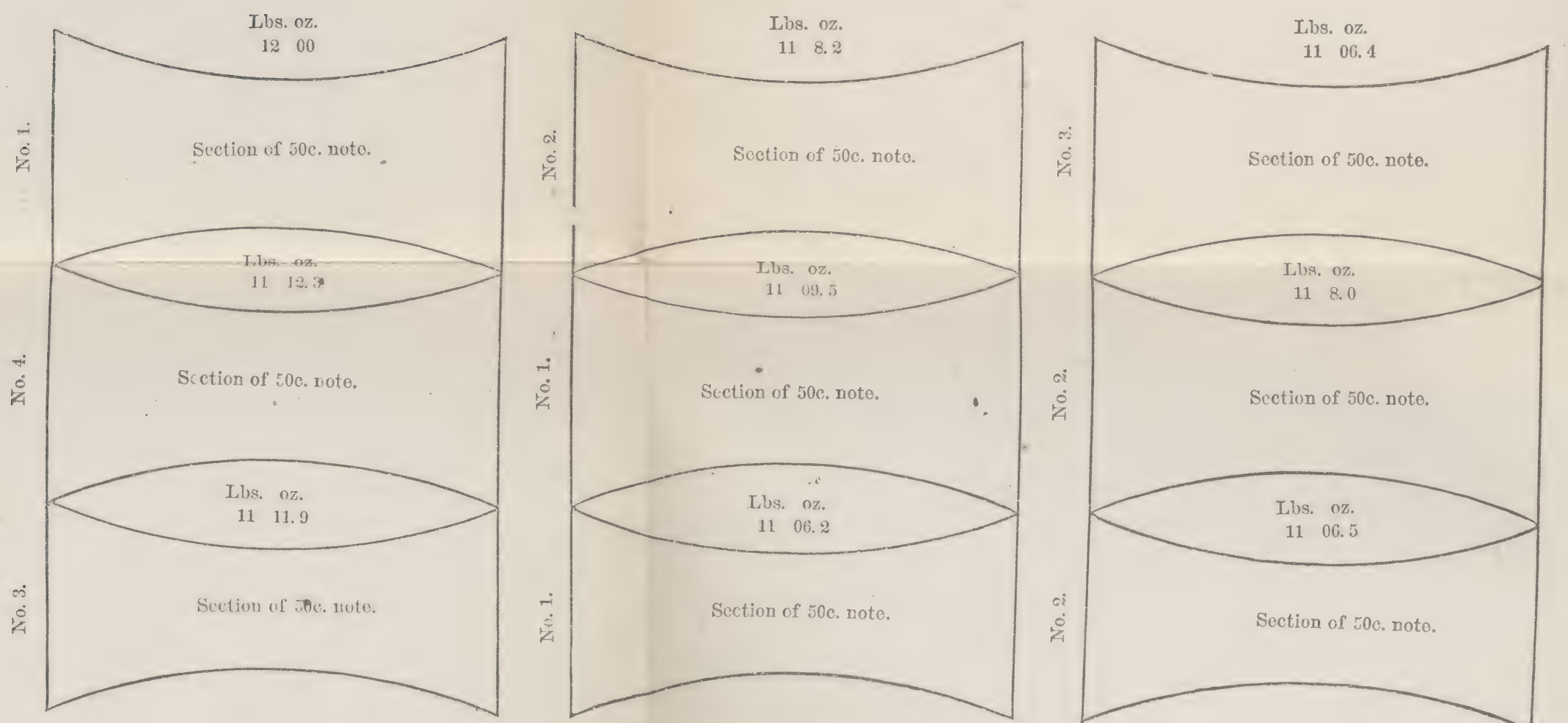




• *Water-proofed and univorn crosswise the note.*

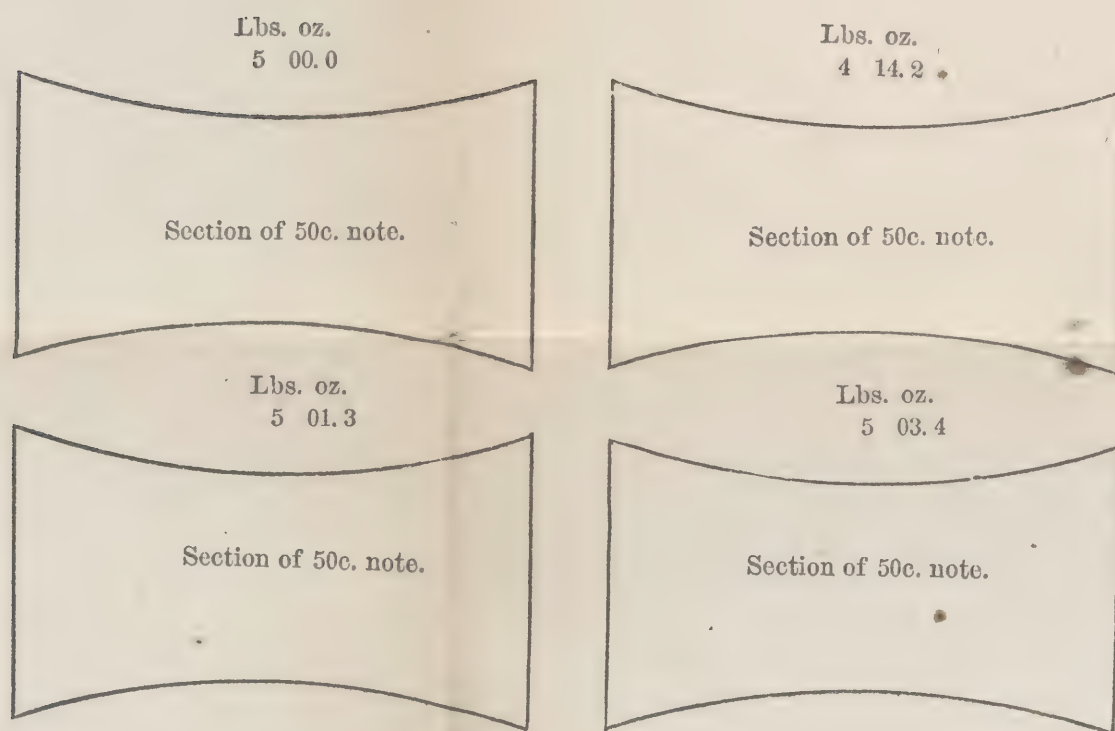
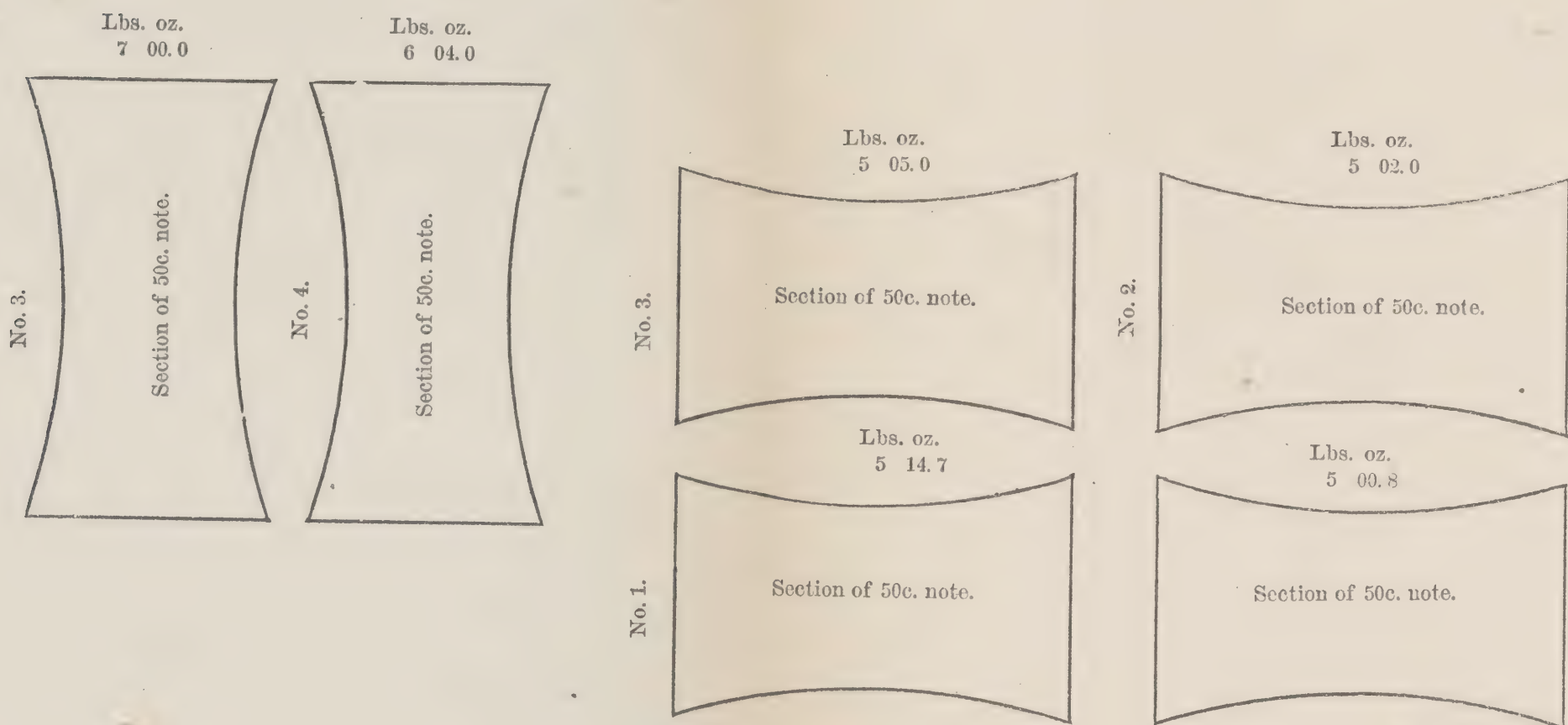
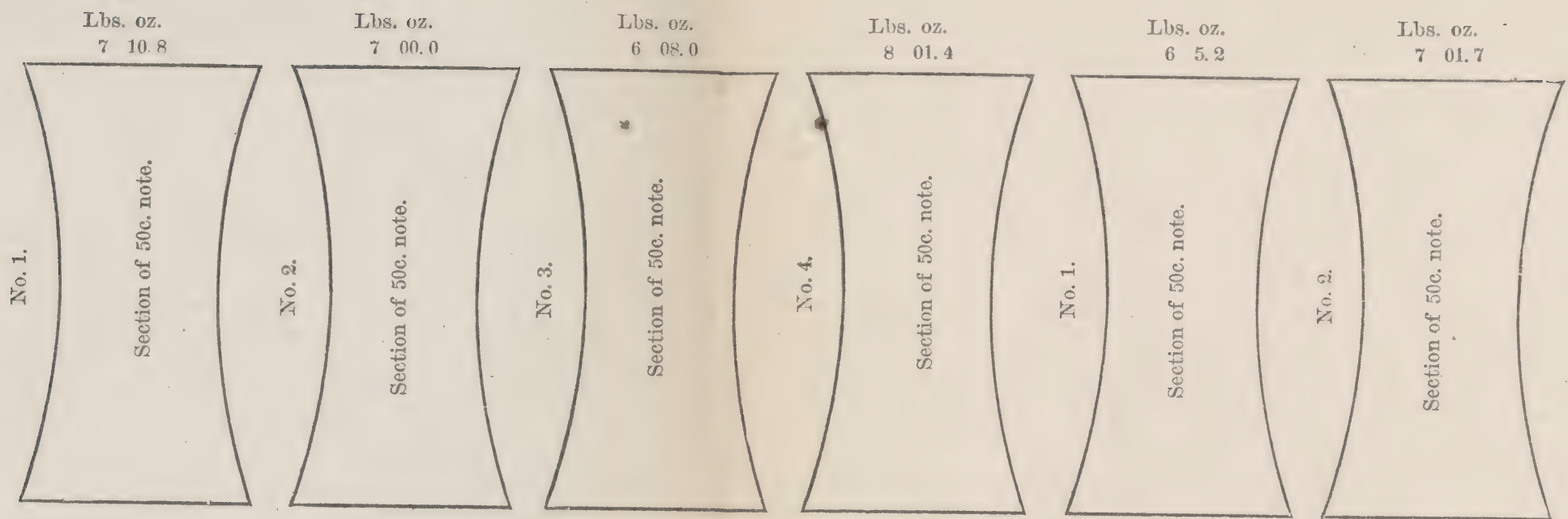


*Water-proofed univorn cut lengthwise the note.*





*Unwater-proofed and worn—Formula 11 =  $\times$ —Face and back alternately multiplied by ten—crosswise the note.*

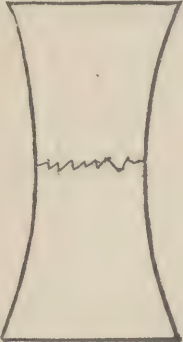
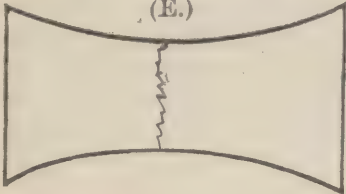








The following are the average breaking-strains from sixty-four tests :

	Unworn notes.		Worn notes.	
	Plain.	Water-proofed.	Plain.	Water-proofed.
(C.) 	<i>Lbs. oz.</i> 14 15.3	<i>Lbs. oz.</i> 16 8.6	<i>Lbs. oz.</i> 6 15.8	<i>Lbs. oz.</i> 6 15.1
(E.) 	9 4.2	11 9.2	5 3.2	5 1.6

From these results the following deductions are obvious:

1. The "plain" paper is 62 per cent. stronger crosswise than lengthwise.
2. "Water-proofing" increases the strength of the new note 10 per cent. crosswise and 25 per cent. lengthwise.
3. After a certain wear, which leaves the note still in good condition for circulation, the effect of the "water-proofing" entirely disappears. Specimens of the artificially-worn notes are herewith submitted.

*Notes worn artificially, in manner described:*

Copy of 50c. note.
Loss of weight by wear—
$\frac{1}{84}$

Unwater-proofed.

Copy of 50c. note.
Loss of weight by wear—
$\frac{1}{62}$

Water-proofed.

Further experiments were made on the quality of resisting the absorption of water on the 50-cent fractional currency. The notes were weighed dry, then immersed in water for a definite length of time, and, after taking off the surface-moisture by means of blotting-paper, in as uniform a manner as possible, were weighed again. The following are the averages of numerous experiments.

1. Notes immersed in water 1 minute:  
Water-proofed gained  $22\frac{1}{2}$  per cent. in weight.  
Plain gained 28 per cent. in weight.
2. Notes immersed in water 5 minutes:  
Water-proofed gained  $53\frac{1}{2}$  per cent. in weight.  
Plain gained 53 per cent. in weight.

Hence, it appears that the advantage as to "water-proofing," properly speaking, is insignificant. The original record of the experiments on tensile strength, and of those on resistance to moisture, is appended.

J. E HILGARD.



FIFTY-CENT NOTES.—*Weighings and wettings ; notes un worn.*

## WATER-PROOFED.

Note No. 1. Weighs 527.7 milligrams, dry. Weighs 827 milligrams, soaked 5 minutes.  
 Note No. 2. Weighs 512.0 milligrams, dry. Weighs 802 milligrams, soaked 5 minutes.  
 Note No. 3. Weighs 507.0 milligrams, dry. Weighs 773 milligrams, soaked 5 minutes.  
 Note No. 4. Weighs 517.1 milligrams, dry. Weighs 797 milligrams, soaked 5 minutes.  
 Note No. 5. Weighs 513.2 milligrams, dry. Weighs 756 milligrams, soaked 5 minutes.

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 5)2576

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 515

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 5)3955

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 791

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 515

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 515)276(53.6%

## UNWATER-PROOFED.

Note No. 1. Weighs 528.5 milligrams, dry. Weighs 808 milligrams, soaked 5 minutes.  
 Note No. 2. Weighs 534.8 milligrams, dry. Weighs 788 milligrams, soaked 5 minutes.  
 Note No. 3. Weighs 512.0 milligrams, dry. Weighs 756 milligrams, soaked 5 minutes.  
 Note No. 4. Weighs 514.4 milligrams, dry. Weighs 776 milligrams, soaked 5 minutes.  
 Note No. 5. Weighs 508.2 milligrams, dry. Weighs 844 milligrams, soaked 5 minutes.

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 5)2598

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 520

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 5)3972

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 794

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 520

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 520)274(53%

## WATER-PROOFED, NOT WORN ; SOAKED ONE MINUTE.

No. 1. 490 milligrams, dry.	586 milligrams.
No. 2. 496 milligrams, dry.	590 milligrams.
No. 3. 495 milligrams, dry.	631 milligrams.
No. 4. 489 milligrams, dry.	598 milligrams.
No. 5. 486 milligrams, dry.	602 milligrams.
No. 6. 494 milligrams, dry.	607 milligrams.

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 2950

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 3614

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 2950=22.5%

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 664

## NOT WATER-PROOFED, NOT WORN ; SOAKED ONE MINUTE.

No. 1. 559 milligrams, dry.	709 milligrams.
No. 2. 551 milligrams, dry.	731 milligrams.
No. 3. 537 milligrams, dry.	687 milligrams.
No. 4. 524 milligrams, dry.	664 milligrams.
No. 5. 554 milligrams, dry.	689 milligrams.
No. 6. 559 milligrams, dry.	727 milligrams.

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 3284

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 4207

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 3284

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 3284)9230(28.1%

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 6568

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 26620

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 26272

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 3480



## C.

NATIONAL ACADEMY OF SCIENCES,  
Washington, D. C., March 23, 1874.

SIR: I have attentively studied the report of the commission of the National Academy, of which you are chairman, appointed, at the request of the Secretary of the Treasury, to investigate the water-proofing of the "fractional currency," and beg leave to respectfully request the commission through you to reconsider their decision in the matter.

I make the request in consequence of not being myself able from the results of the experiments of the commission to arrive at their conclusion, viz, that "the process of water-proofing is of no appreciable advantage as to the durability of the notes."

The experiments appear to have been ingeniously devised and carefully made, but, as it seems to me, they are not sufficient to settle the point in question. They consist essentially in determining the comparative tensile strength of the notes that have been "water-proofed" and those which have not been "water-proofed" before and after having been subjected to a weakening process. Taking the results as given as absolutely true, it appears, first, that the water-proofed notes are stronger at first than those which have not been subjected to the process; and, second, that after being subjected to a weakening process they are of nearly the same strength.

In regard to the latter result, I have to say that it is arrived at by subjecting the note to a manipulation which breaks the fiber and destroys the effect of the water-proofing, and which reduces the note to a condition similar to that in which it is found after having been a certain length of time in circulation. But it does not follow that, because two notes by violent manipulation are suddenly brought into nearly the same condition, that two notes in circulation would be brought into the same condition in the same length of time. It might require one of them to be subjected to *double the time* of wear before arriving at the same condition as that of the other, *time* in this case being the essential element.

Furthermore, it appears to me that the process employed of creasing the note, by means of an ivory folder after rolling it on a hexagon pencil, is unlike the usage to which the smaller notes are subjected in actual circulation. In the latter case they are carried in portemonnaies of the size of the notes, or, more usually, made up into rolls and carried either in pocket-books or in the open pocket. I am the more confirmed in the foregoing opinions by the fact of having myself made a series of experiments which consisted in weighing notes thoroughly dried by artificial heat, then subjected to wear by simultaneously brushing two specimens of the same denomination—the one plain, the other water-proofed—drying after brushing, and weighing again, noting the loss. In all cases I found that the water-proofed specimens indicated less wear than the unwater-proofed.

The process was varied by simultaneously dampening with wet blotting-paper the two specimens at the end of every five brushings, care being taken to dry at the beginning before weighing, and again at the end of the process. In these cases the wear was more rapid and the difference in the loss greater than in that in which the notes were brushed in a dry condition.

I beg leave to assure the committee that, in assuming the responsibility of referring the subject back to them for further study of the



questions submitted, I am actuated alone by an earnest desire that the National Academy of Sciences should not adopt any conclusions against which objections of data or logic can be justly raised.

I am awakened to the importance of extreme caution in this case by the fact that the Secretary of the Treasury has presented to me for additional light a second report in regard to the subject, by Professor Ordway, of the Massachusetts Institute of Technology, adverse to the views of the committee of the Academy, which, from its character, as well as that of the professor himself, is deserving of attention.

Moreover, I am induced to unusual circumspection, perhaps, in the present instances, inasmuch as the subject is exciting public attention and the report of the committee of the Academy is cited in favor of both sides of the question.

I do not intend by this communication to convey the idea that I am myself prepared to advocate the importance of the water-proofing system now in use in the Treasury Department, but that I am not convinced of its worthlessness for the reasons set forth in the report of the committee.

I have the honor to be, yours, very truly,

JOSEPH HENRY,

*President National Academy of Sciences.*

Prof. J. E. HILGARD,

*Chairman Committee of National Academy of Sciences, &c.*

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D.

DEAR SIR: We have given careful attention to your letter requesting us to reconsider our report, and, in view of the facts presented by you, have somewhat modified the statement of our conclusions. We have also more particularly set forth our reasons for choosing the mode of testing adopted by us, which we cannot but conceive to represent faithfully the effect of actual wear in circulation. It is only by crumpling and short folding that the notes are ever reduced to the condition in which we actually find them. It may be assumed that, whether water-proofed or not, the notes would receive the same number of "handlings" in the same time, and the experiments show that, after a certain equal amount of hard usage, there is no longer any difference in favor of the water-proofed notes. So long as the notes are not subjected to hard usage, for instance, while they are kept flat in a pocket-book, and are neither folded nor crumpled, whether dry or moist, they suffer so little wear as not to call their relative durability into serious question. Their endurance is only tested when they are subjected to such usage as reduces them to the condition in which we actually find them in circulation. It is their power to resist the greatest duress to which they are actually subjected that must determine the value of the process. These considerations prevent us, with entire respect to your dissenting view, from ascribing any practical utility to the water-proofing process, and from recommending its continuance. It should be remembered that this conclusion has been forced upon us, contrary to our original views, which were favorable to the process.

We have also carefully examined the report of Professor Ordway, which you have submitted to us, and are surprised to find that, with one exception, it contains no experiments such as were reported in his original communication on the subject, or are in any way comparable



with those then made by him or since made by us, and yet we find him reiterating his former conclusions and stating his belief that the process then used, and which gave him results directly opposed to ours where the methods were the same, is still employed on no apparent ground, except his ignorance as to the process then employed. His late experiments we regard as, with one exception, irrelevant to the question at issue. If it were customary to boil fractional-currency notes in water, whether distilled or salt, or to wear them in the boots, or to roll them on rough bricks, or to bray them in a mortar, some valuable deduction might be made from Professor Ordway's experiments, but as none of these things are either customary or in any way equivalent to the customary treatment of notes, which is simply to fold or crumple them in the pocket or pocket-book, we quite fail to trace any connection between these experiments of Professor Ordway and the answer to the question, "How does water-proofing affect the durability of the notes in actual use?" The experiments on the tensile strength of the fresh and unworn notes are the only ones which seem to bear upon the subject, and of these there are only four sets, among which the irregularities are so great that while the average shows largely in favor of the water-proofed notes, individual cases could be selected which would give the advantage to the untreated notes. The notes tested for tensile strength after wetting, of which there were three sets, show less in favor of the water-proofing. But as neither of these involve any of the essential conditions of actual wear, they are of little value, and indeed only differ in degree from the results obtained by us as the average of nearly a hundred very accordant experiments.

In conclusion, we beg leave to assure you that we do full justice to the motives which led you to recommit the report to us, and remain, dear sir, with great regard,

Your obedient servants,

J. E. HILGARD.  
HENRY MORTON.  
C. T. CHANDLER.  
WM. SELLERS.

Prof. JOSEPH HENRY,  
*President National Academy of Science.*

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E.

*Remarks by the president of the Academy on the foregoing.*

The foregoing reply to my letter did not change, in the least degree, my opinion as previously expressed. I still adhered to the opinion that a note having 20 per cent. greater initial strength will wear longer in actual use than one that is not thus strengthened, and that the experiments adduced by the commission to the contrary do not logically bear out their conclusions. The error consists, in my opinion, in assuming that because two notes in equal times by violent manipulation, such as creasing a hundred and sixty times in succession in different directions by an ivory folder, are deprived of the advantages of the water-proofing process, therefore, two notes in actual use and not necessarily submitted to the same violence should arrive at the same condition in the same time. Similarity of condition does not necessarily prove that similarity of force has been applied to produce the condition. The same effect may be produced by a force of double intensity acting in half the time.



## F.

MASSACHUSETTS INSTITUTE TECHNOLOGY,  
*Boston, February 24, 1876.*

DEAR SIR: Having been requested through you by the honorable the Secretary of the Treasury to examine into the water-proofing process, during a recent visit to Washington, "to ascertain whether there has been any change in the material," I beg leave to report as follows:

A good part of two days was devoted to examining the operations conducted by the Bureau of Engraving and Printing. Viewing the whole from a practical manufacturer's stand-point, I must say that, though the work of the bureau is done under some disadvantages on account of limited space, it is done with admirable care, skill, and economy.

For experiments on the effects of water-proofing as at present carried on, I selected from a lot of printed and stamped 25-cent currency two sheets, apparently alike in colors, thickness, and weight. One being reserved as it was, the other was passed, in my presence, through the water-proofing operations, along with the regular work. Both were pressed as usual. There being neither time nor facilities for making tests on the spot, the two sheets were duly receipted for, with the understanding that they should be destroyed or returned, and they were brought home for comparative trials.

1. The unprepared sheet weighed 7.3538 grams; the water-proofed sheet weighed 7.5488 grams; showing a gain of 0.1950 gram or 2.65 per cent., in water-proofing.

2. Six pieces of exactly the same size—50 by 63 millimeters—were cut out of each sheet and weighed, to ascertain how much the thickness may vary in different parts of the same sheet of paper.

A, a weighed .....	0.2870 gram	#	B, 1 = .....	0.2973 gram.
A, b weighed .....	0.2943 gram	#	B, 2 = .....	0.3987 gram.
A, c weighed .....	0.2843 gram	#	B, 3 = .....	0.2947 gram.
A, d weighed .....	0.2845 gram	#	B, 4 = .....	0.2995 gram.
A, f weighed .....	0.2905 gram	#	B, 5 = .....	0.3005 gram.
A, h weighed .....	0.2900 gram	#	B, 6 = .....	0.3000 gram.
Average of unprepared .....				0.28843 gram.
Extreme difference (A, b and A, c) .....				0.0100 gram.
Average of water-proofed .....				0.29845 gram.
Extreme difference, (B, 3 and B, 5) .....				0.0058 gram.

These averages show a gain in water-proofing of 3.13 per cent., a greater increase than shown by the whole sheets.

The weighings betray a lack of perfect uniformity in thickness as to comparatively large areas, and a nice sense of touch shows even greater local differences. Hence, in making trials of tensile strength, it is important to guard against comparing a thin part of one sheet with a thick part of another sheet. In fact I found some earlier results so obviously erroneous that they had to be rejected, and was thus led to investigate more closely the matter of thickness.

3. Pieces nine millimeters wide in the narrowest part were cut out by pairs and weighted to breaking:

Water-proofed, 1 took 2,784 grams.  
 Unprepared, 1 took 1,700 grams.  
 Water-proofed, 2 took 2,098 grams.  
 Not water-proofed, 2 took 1,652 grams.  
 Water-proofed, 3 took 2,940 grams.  
 Not water-proofed, 3 took 2,260 grams.  
 Water-proofed, 4 took 3,005 grams.  
 Not water-proofed, 4 took 2,150 grams.



4. Some pieces were dampened over night, as the paper is dampened for printing, the pairs having been previously cut with a least width of nine millimeters:

Water-proofed, 5 broke with 1,180 grams.

Not water-proofed, 5 broke with 990 grams.

Water-proofed, 6 broke with 1,100 grams.

Not water-proofed, 6 broke with 699 grams.

Water-proofed, 7 broke with 1,340 grams.

Not water-proofed, 7 broke with 1,015 grams.

5. Some fine siftings of anthracite-coal ashes were mixed in a Wedgwood mortar, with water, to a thin mud, and equal-sized pieces of the currency were together pounded gently in it for ten minutes.

Another pair of pieces was pounded fifteen minutes.

Another pair was bruised in the mud ten minutes.

Another pair was bruised twenty minutes.

In all these cases the water-proofed pieces resisted the severe trial far better than the unprepared piece.

6. A pair of pieces, weighing respectively .6130 gram and .6519 gram, was rolled up diagonally on a common black-lead pencil 2,100 times—1,400 times on a dry surface, or between the fingers, and 700 times on a rough wet fire-brick. They were put alternately face to face and back to back every twenty rollings. The unprepared piece became so far cracked and torn that further rollings would have been unsafe, while the water-proofed piece was little injured.

There was no decrease in weight, though both pieces felt thinner than at first.

7. Two pieces of the same size, about 90 by 50 millimeters, were worn separately for eight days inside rough woolen stockings, being interchanged every day, and being placed sometimes face up, and sometimes face down. They were then kept imbedded in bone-charcoal long enough for purification.

Both specimens suffered severely, and there was left of the unprepared paper only one piece more than twenty-five millimeters square, and that was badly cracked, while there were still two large pieces of the water-proofed paper in pretty good condition.

8. A pair of pieces was boiled in distilled water sixteen hours.

The water-proofed piece was partially split, but otherwise was less injured than the unprepared one. The red stamp of the unprepared piece was considerably dimmed.

9. A pair of pieces was boiled nineteen hours in sea-water, the evaporated fluid being, from time to time, replaced by sea-water.

After two hours' boiling, the water-proofed piece split within and puffed up like a bladder. Neither piece was seriously damaged, though the brightness of the red stamp on the unprepared piece was much impaired.

The splitting of the water-proofed specimens simply shows that the impregnation had not been absolutely uniform through the entire thickness of the paper.

For want of dog-day weather, it has not been convenient to make any experiments as to relative liability to mold or mildew. There is, however, no reason to suppose that the substance left in the paper by water-proofing is favorable to fungus growths.

Cotton cloth has been known to deteriorate by long keeping in consequence of the presence of injurious chemicals in the starch used for finishing, and the question might well be asked whether this water-proofed paper can in time suffer from the slow action of the substances



with which it is impregnated. There are no experimental data with respect to this point, but I do not see how any of the materials used can tend to produce a gradual weakening of the fiber.

To the first question asked by the honorable Secretary, "whether or not there has been any change in the material," I cannot give a positive answer. At the time of making my former trials I had seen no one connected with the bureau, and had not been told what the water-proofing materials were. The impregnating matter in the specimens of paper then sent to me appeared to be such as would result from the application of the chemicals which I found in use at the time of my visit. These materials are the best that the market affords. I think there has been no change.

The other question is, "whether I am still of the same opinion as when I made my last report." The experiments lately made have fully confirmed the opinion which I expressed before, that the water-proofing process decidedly improves the currency, and that its use should be continued.

It is not unlikely that slight improvements may be made in the details of the process, but I doubt whether any essentially different method can be devised that could be at once so practicable, efficient, innocuous, and economical.

In conclusion, allow me to express my grateful sense of the courtesy and unreserved frankness which were shown by you and your subordinates in answering all questions relating to the work done under your charge.

Very respectfully, yours,

JOHN M. ORDWAY.

Hon. GEORGE B. McCARTEE.

Four cards, containing illustrative specimens of destructive work, are sent herewith.